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MANUAL OF RECOMMENDED PRACTICE

FOR

RAILWAY ENGINEERING AND MAINTENANCE OF WAY

CONTAINING THE

DEFINITIONS, SPECIFICATIONS AND PRINCIPLES OF PRACTICE ADOPTED AND RECOMMENDED BY THE AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION

PUBLICATION APPROVED BY THE BOARD OF DIRECTION

EDITION OF 1907.

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BY THE

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION.

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PREFACE.

EDITION OF 1905.

At the Fifth Annual Convention of the American Railway Engineering and Maintenance of Way Association, held at Chicago in March, 1904, it was decided to publish a Manual of the Recommended Definitions, Specifications and Principles of Practice for Railway Engineering and Maintenance of Way Work adopted by the Association at its conventions after due consideration of reports on the various subjects submitted by standing or special committees of the Association.

Owing to the importance and weight that should be justly attributed to the deliberate and carefully expressed opinion of an Association comprising prominent railway officials and specialists in the various classes of work and duties connected with the location, construction, maintenance and operation of railroads, and the influence that this publication will undoubtedly have on railway engineering and maintenance of way work in this country, the Board of Direction has exercised particular care to include in the Manual only such matter as has been carefully and sufficiently considered by the Association prior to its adoption by vote at the annual conventions so as to warrant its publication in this Manual as the practice recommended by the Association. The Manual will be supplemented or issued annually after each annual convention and kept up-to-date by such additions and revision of previously published matter as may be decided on by the Association at each convention, working under special rules governing the publication of the Manual.

The action of the Association in adopting and publishing definitions, specifications and principles of practice is in the nature of recommendations only and not binding on its members or railway companies. It is distinctly within the sphere of the Association's work, as expressed in Article I of its Constitution, viz.:

"The object of this Association shall be the advancement of knowledge pertaining to the scientific and economical location, construction, operation and maintenance of railroads.

"The means to be employed for this purpose shall be as follows:

"Meetings for the reading and discussion of papers and for social intercourse.

"The investigation of matters pertaining to the objects of this Association through Standing and Special Committees.

"The publication of papers, reports and discussions.

"The maintenance of a library."

As illustrative of the aims and methods of the Association, the following extracts from the remarks of Mr. John F. Wallace, formerly Chief Engineer of the Isthmian Canal Commission and General Manager of the Illinois Central Railroad, in his inaugural address as the President of the Association at its First Annual Convention in Chicago, March, 1900, will prove pertinent:

"It is unnecessary for me to say that this Association fills a long-felt want, and that it has a broad field to develop. If the work is industriously and systematically carried forward, it will gradually assist us all in attaining the end sought for.

"It has been the custom of engineering and maintenance of way associations heretofore to carry on their work without that system and continuity of purpose which is the only true means of successfully accomplishing the desired results. The work of our Association has been laid out on unique lines. It is the intention to cover the entire field of engineering and maintenance of way research, divide up the subjects in systematic order, and continue and increase our standing committees and the subjects under consideration from time to time in order to do so.

"The first work of each committee should be the collection of facts, which should be properly compiled, condensed and abstracted for the information of the Association at large. As the facts are obtained under the different heads or sub-heads, reports can, of course, be made from time to time by the different committees on these subjects which have been considered.

"The committee should not overlook the necessity and importance of working as a unit and fully comparing and discussing results in committee meetings. When they come before this Association as a body they should come as a unit and act together, and it is expected that they will be prepared to answer all questions that may be asked by members of the Association in regular meetings, and explain or defend the positions taken by the committee.

"We should not forget that we are the servants of the investors in railway securities, and that it is our duty to endeavor to secure the largest possible return on the capital invested. It is the function of the railway to furnish transportation to the public with the maximum amount of speed and safety to person and property, the greatest convenience to its patrons, and at minimum cost. We should have it

in mind that the highest economy in the location, construction, maintenance and operation can only be obtained when the interest on cost of construction, plus the expense of maintenance and operation, are kept down to the minimum.

"The ultimate result of all railroad expenditures is, and should be, net profit to the investor.

"While the question of what is economical management respecting maintenance of way and structures is one which the management of each property must solve for itself, we can certainly assist each other by a full and frank comparison of views and a discussion of the various elements that constitute an economical handling of our maintenance of way work. *The establishment of certain recognized principles as the result of our investigations and discussions will materially assist our managements in adopting a policy that will lead to the truest and highest economy.*"

EDITION OF 1907.

The "Edition of 1905" of the Manual covered the period of the Association's work from its first Annual Convention in March, 1900, to and including the sixth Annual Convention in March, 1905.

The amendments and addenda to the Manual, adopted by the Association at its seventh Annual Convention in March, 1906, were published in Bulletin No. 79, September, 1906, as "Supplement of 1906, Addenda to Edition of 1905."

The changes and additions to the Manual since the "Edition of 1905" have been such as to warrant a complete republication of same, corrected and supplemented in accordance with the action of the Association at its Annual Conventions in 1906 and 1907.

The present "Edition of 1907" contains concisely all matter, in its final and duly authorized form, as adopted after due consideration by the Association at the various Annual Conventions from 1900 to and including the eighth Annual Convention in March, 1907, as reported in the Proceedings of the Association, Volume 1, 1900, to Volume 8, 1907.

LIST OF COMMITTEES.

No. I—ROADWAY.

No. II—BALLASTING.

No. III—TIES.

No. IV—RAIL.

No. V—TRACK.

No. VI—BUILDINGS.

No. VII—WOODEN BRIDGES AND TRESTLES.

No. VIII—MASONRY.

No. IX—SIGNS, FENCES, CROSSINGS AND CATTLE-GUARDS.

No. X—SIGNALING AND INTERLOCKING.

No. XI—RECORDS, REPORTS AND ACCOUNTS.

No. XII—UNIFORM RULES, ORGANIZATION, TITLES, CODE, ETC.

No. XIII—WATER SERVICE.

No. XIV—YARDS AND TERMINALS.

No. XV—IRON AND STEEL STRUCTURES.

No. XVI—ECONOMICS OF RAILWAY LOCATION.

SPECIAL COMMITTEE ON CLASSIFICATION OF TRACK.

SPECIAL COMMITTEE ON UNIFORM GENERAL CONTRACT FORM.

COMMITTEE NO. I.

ROADWAY.

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*ROADWAY.

DEFINITIONS.

GROUP A—GENERAL.

CLASSIFICATION.—Separating the material into groups according to its character.

CONTRACT.—A written agreement between two or more parties specifying terms, conditions, etc., under which certain obligations must be performed. (Specifications are a part of the contract.)

ESTIMATE (noun).—(a) A statement of work performed or material delivered, according to which payment is to be rendered.

(noun).—(b) A statement showing the probable cost of a proposed piece of work.

(verb).—The act of making an estimate.

QUANTITIES.—The amount of material to be handled, expressed in the usual units.

SPECIFICATION.—That part of the contract describing the details of construction.

UNIT PRICE.—The price per unit of the various quantities specified in a contract for which a certain work is to be done.

GROUP B—RIGHT-OF-WAY, ETC.

RIGHT-OF-WAY.—The land or water rights necessary for the roadbed and its accessories.

ROADBED.—The finished surface of the roadway upon which the track and ballast rest.

ROADWAY.—That part of the right-of-way of a railroad prepared to receive the track.

STATION GROUNDS.—Property to be used for station purposes.

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* Adopted, Vol. 7, 1906, pp. 341-343, 442, 443.

GROUP C—TECHNICAL.

ALINEMENT.—The horizontal location of a road with reference to curves and tangents.

CENTER LINE.—A line marking the center of an excavation, embankment or of a track.

CONTOUR.—The line of intersection between a horizontal plane and a given surface.

CROSS-SECTION.—A section through a body perpendicular to its axis.

CENTER STAKES.—Stakes marking the center line.

ELEVATION OR HEIGHT.—The distance of any given point above or below an established plane.

FINISHING STAKES.—Final stakes set for the completion of work.

GRADE (verb).—To prepare the ground for the reception of the ballast and track.

GRADE-LINE.—The line on the profile representing the tops of embankments and bottoms of cuttings ready to receive the ballast.

GRADIENT.—The rate of inclination of the grade-line from the horizontal.

PLAN.—A drawing furnished for guidance of work.

PROFILE.—The intersection of a longitudinal vertical plane with the ground or established gradients; or a drawing representing the same.

SLOPE.—The inclined face of a cutting or embankment.

SLOPE STAKES.—Stakes set to mark the top or bottom of a slope.

SUBGRADE.—The tops of embankments and bottoms of cuttings, ready to receive the ballast.

TOP OF SLOPE.—The intersection of a slope with the ground surface in cuts, and the plane of roadbed on embankment.

TOE OF SLOPE.—The intersection of a slope with the ground surface in embankments, and the plane of roadbed in cuts.

GROUP D—CLEARING, ETC.

BRUSH.—Small trees, shrubs or branches of trees that have been cut off.

CLEARING.—Removing natural and artificial obstructions to grading.

GRUBBING.—Removing the roots.

GROUP E—DRAINAGE, ETC.

BOG.—Wet or spongy ground.

CHANNEL.—The depression or cut in which a stream is confined.

CULVERT.—An arched, circular or flat covered drain of timber, iron, brick, or masonry, carried under the roadbed for the passage of water.

DRAIN.—An artificial waterway for conducting water from the roadway.

DRAINAGE.—The interception and removal of water from, upon or under the roadway.

DITCH.—An open artificial waterway for providing drainage.

INTERCEPTING DITCH.—An open, artificial waterway for preventing surface water from flowing over the slopes of a cut or against the foot of an embankment.

SUBDRAIN.—A covered drain, below the roadbed or ground surface, receiving the water along its length by absorption or through the joints.

TRENCH.—A narrow, shallow excavation, to receive a structure.

WATERWAY.—A channel, either natural or artificial, for conducting the flow of water.

GROUP F—GRADING, ETC.

AVERAGE HAUL.—The mean distance that material must be hauled.

AVERAGE TOTAL HAUL.—The average total distance that material must be hauled.

BENCHED.—Formed into a series of benches.

BERME.—An approximately horizontal surface between the top or toe of a slope and a boundary line, ditch or other excavation, for the protection of the slope.

BORROW (verb).—To take material from a borrow bit.

(noun).—Material removed from a borrow pit.

BORROW PIT.—An excavation made for the purpose of obtaining material.

EMBANKMENT (or fill).—A bank of earth, rock or other material constructed above the natural ground surface.

EXCAVATION (or cutting).—(a) The cutting down of the natural ground surface.

(b) The material taken from cuttings, borrow pits or foundation pits.

(c) The space formed by removing material.

FOUNDATION PIT.—The excavation in which the foundation of a structure is laid.

HAUL, OR FREE HAUL.—The distance within a given limit that material is hauled in constructing the roadbed.

OVERHAUL.—The distance beyond a given limit that material is hauled in constructing the roadbed.

SHRINKAGE.—The contraction of material.

STEPPED.—Formed into a series of steps.

TAMPED (or packed).—Packed down by light blows.

TOTAL HAUL.—The total distance that material must be hauled.

WASTE.—Material in excess of that required to make an embankment of given cross-section.

WASTE, or SPOIL BANKS.—Excavated material not used to form embankments.

GROUP G—TUNNELS, ETC.

CURB.—A broad, flat ring of wood, iron or masonry, placed under the bottom of a shaft to prevent unequal settlement, or built into the walls at intervals for the same purpose.

ROCK.—A solid mass of mineral substance.

SHAFT.—A pit or well sunk from the ground surface above into a tunnel for the purpose of furnishing ventilation or for facilitating the work by increasing the number of points from which it may be carried on.

TUNNEL.—An excavated passageway under ground or water.

WELL, or SUMP.—A cistern or well into which water may be conducted by ditches to drain other portions of a piece of work.

*WIDTH OF ROADBED AT SUBGRADE.

RECOMMENDED PRINCIPLES OF PRACTICE.

It is recommended that on first-class roads of standard gage, with constant and heavy traffic, a minimum permanent width of twenty feet at subgrade is good practice.

That in the theory upon which the width of embankment at subgrade is based it is considered that the track in excavations is placed upon what is virtually a low embankment, and in order to preserve uniformity of conditions immediately under the track throughout the line the width of subgrade in excavations should be made the same as on embankments, outside of which sufficient room must be allowed for side ditches.

†SLOPES OF ROADBED CROSS-SECTION.

RECOMMENDED PRINCIPLES OF PRACTICE.

Local conditions and the character of material should invariably be taken into account in determining the permanent slopes of the roadbed cross-section.

* Adopted, Vol. 3, 1902, pp. 34, 37, 43; Vol. 6, 1905, pp. 122, 123.
† Adopted, Vol. 3, 1902, pp. 34, 45; Vol. 6, 1905, pp. 122, 123.

*SPECIFICATIONS FOR THE CONSTRUCTION OF ROADWAY.

RECOMMENDED PRINCIPLES OF PRACTICE.

(1) Similarity in form of specifications.

(2) Measurements of clearing and grubbing should be made in units of one hundred (100) ft. square.

(3) A threefold classification of materials: Solid Rock, Loose Rock and Common Excavation, and in special cases such additional classification of material as may seem necessary, such additional classes to be distinctly defined and specified in the contract.

(4) Profiles should be made complete in regard to distribution of material, in order to obviate the necessity for overhaul measurements.

†DESIGN AND CONSTRUCTION OF ROADWAY.

RECOMMENDED PRINCIPLES OF PRACTICE.

(1) There should be recognized three widths of roadbed for standard gage railways, and these should be selected to suit the probable density of traffic to be handled in the future. These widths should be 14, 16 and 20 ft.

(2) A width of 13 ft. between center lines of main tracks is recommended.

(3) Rock excavations should be taken out not less than 6 in. below subgrade.

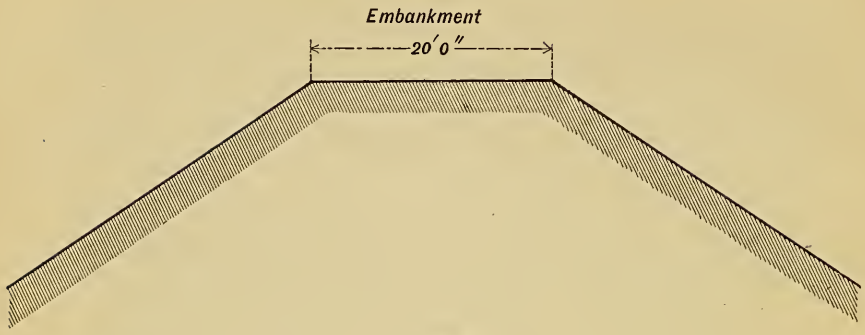
(4) No wasting should be allowed closer than 10 ft. from slope stakes.

(5) Information on profiles as to distribution of material should be so arranged that price for grading for each of the classes may cover the haul, irrespective of distance.

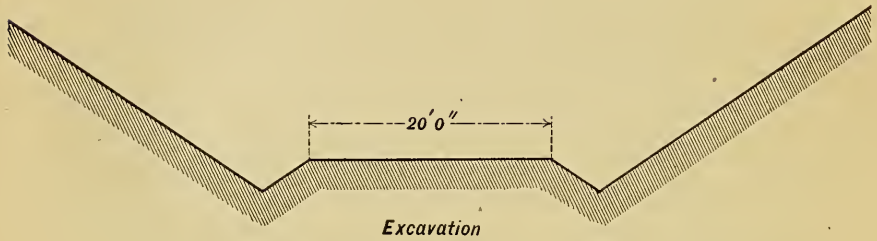
* Adopted, Vol. 4, 1903, pp. 32, 35, 39, 44, 66, 74; Vol. 5, 1904, pp. 688, 719; Vol. 6, 1905, p. 123.

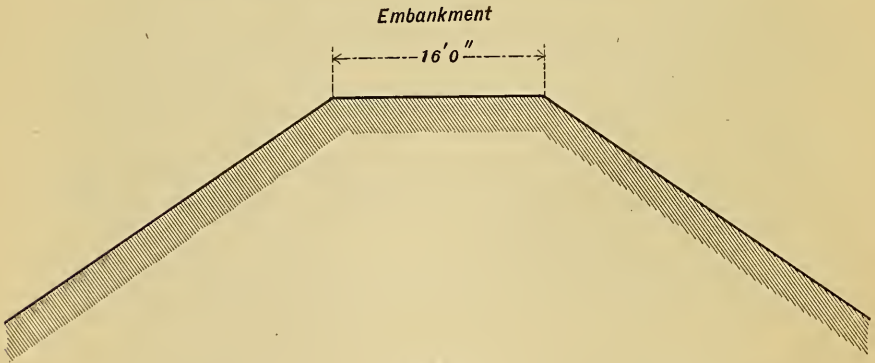
† Adopted, Vol. 6, 1905, pp. 136-138, 142, 144, 145, 164-173.

STANDARD ROADBED PLANS.

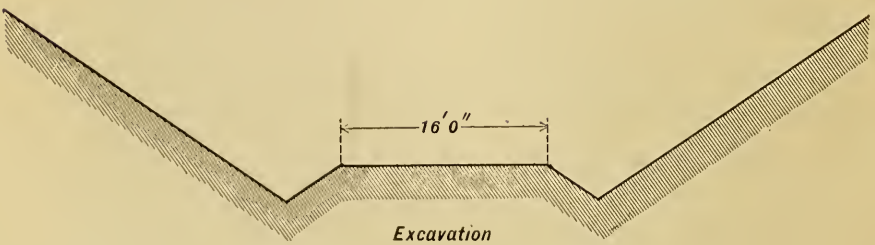


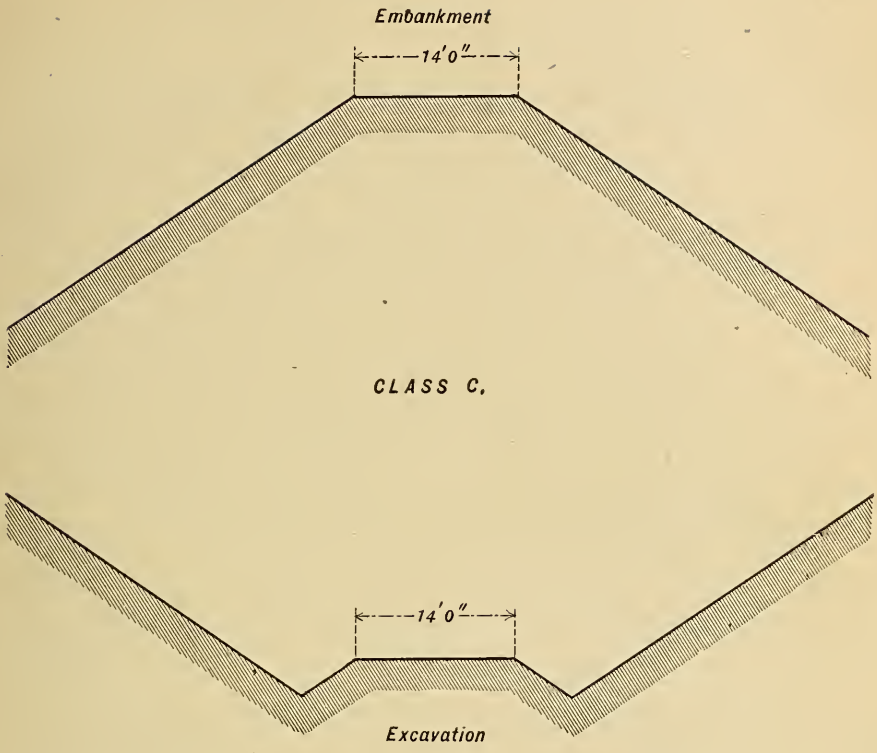
CLASS A.





CLASS B.





*SPECIFICATIONS FOR THE FORMATION OF THE ROADWAY.

RECOMMENDED STANDARD SPECIFICATIONS.

IN GENERAL.

1. The center of the roadbed shall conform in alinement to the center stakes. Alinement.

2. The grade-line on the profile denotes subgrade, and this term indicates the top of embankments or the bottom of excavations ready to receive the ballast. Subgrade.

3. The roadbed shall be formed to the sections, slopes and dimensions shown upon the standard drawings, or to such modifications thereof as are required to meet special conditions, as may be from time to time directed. Cross-section.

4. When finished and properly settled the roadbed shall conform Width of Roadbed.

* Adopted, Vol. 4, 1903, pp. 20-29, 33-35, 78-109; Vol. 5, 1904, pp. 675-684, 688, 719; Vol. 6, 1905, pp. 125-136, 143-164.

to the finishing stakes and shall be of the following dimensions at subgrade, for single track, viz.:

On embankments ..... (....) ft. wide, and in excavations ..... (....) ft. exclusive of the width necessary for ditches. For each additional track an additional width of ..... (....) ft. shall be made.

Slopes.

5. The slopes of embankments and excavations shall be of the following inclinations, as expressed in the ratio of the horizontal distance to the vertical rise:

Embankments, Earth—One and one-half to one;
Rock—From one to one, to one and one-half to one;

Excavations, Earth—One and one-half to one;
Loose Rock—One-half to one;
Solid Rock—One-quarter to one.

These ratios may be varied according to circumstances, and the slopes shall be made as directed in each particular case.

CLEARING.

Extent of Clearing.

6. The right-of-way and station grounds, except any portions thereof that may be reserved, shall be cleared of all trees, brush and perishable materials of whatever nature.

Disposal of Brush, Etc.

7. All these materials, except such as may be hereinafter mentioned, shall be burned or otherwise removed from the ground, as may be directed, and without injury to adjoining property.

Stumps.

8. Where clearing is to be done, stumps shall be cut off even with the ground, except between the slope stakes of embankments, where stumps may be cut so that the depth of filling over them shall not be less than two and one-half (2½) ft.

Clearing in Advance.

9. The work of clearing shall be kept at least one thousand (1,000) ft. in advance of grading.

Cutting and Piling Wood.

10. All trees which may be reserved shall be stripped of their tops and branches, made into ties, or cut to such lengths as may be directed, and neatly piled at such places on the right-of-way as may be designated, for which service payment shall be made by the tie, or by the cord of one hundred and twenty-eight (128) cubic ft.

Fences, Annual Growths, Isolated Trees, Buildings, Etc.

11. Fences, grain, grass or other annual growths and other movable property on the right-of-way shall be carefully removed or piled up, as may be directed, without extra charge, it being understood that the price for clearing covers these items. In localities where isolated trees and

buildings exist, payment shall be made for their removal at a price to be agreed upon.

Measurement. 12. Measurement of clearing and payment for the same shall be by units of one hundred (100) ft. square, or fraction thereof, actually cleared.

GRUBBING.

Extent. 13. Stumps shall be grubbed entirely from all places where excavations occur, including ground from which material is to be borrowed as well as from ditches, new channels for waterways and other places where required.

Grubbing shall also be required between the slope stakes of all embankments of less than two and one-half (2½) ft. in height.

Grubbing in Advance. 14. The work of grubbing shall be kept at least three hundred (300) ft. in advance of grading.

Measurement. 15. Measurement of grubbing shall be estimated upon all excavation actually done, and the space to be covered by all embankments of less than two and one-half (2½) ft. in height. Payment for the same shall be by units of one hundred (100) ft. square, or fraction thereof, actually grubbed.

GRADING.

Work Included. 16. The term "Grading" in these specifications includes all excavations and embankments for the formation of the roadbed, ditching, diversions of roads and streams, foundation pits, and all similar works connected with or appertaining to the construction of the railway, its sidetracks and station grounds.

Classification. 17. All material excavated shall be classified as "Solid Rock," "Loose Rock," "Common Excavation," or such additional classifications of material as may be established before the award of the contract.

Solid Rock. 18. Solid Rock shall comprise rock in solid beds or masses in its original position which may be best removed by blasting, and boulders or detached rock measuring one cubic yard or over.

Loose Rock. 19. Loose Rock shall comprise all detached masses of rock or stone of more than one cubic foot and less than one cubic yard, and all other rock which can be properly removed by pick and bar and without blasting; although steam shovel or blasting may be resorted to on favorable occasions in order to facilitate the work.

Common Excavation. 20. Common Excavation shall comprise all other materials of whatever nature that do not come under the classification of solid rock

or loose rock or such other classifications as may be established before the award of the contract.

Finishing Slopes.

21. Slopes of all excavations shall be cut true and straight, and all loose stones in the slopes shall be removed.

Excavation Below Subgrade.

22. Rock excavation shall in all cases be taken out .....(....) in. below subgrade and refilled to subgrade with approved material.

Excess Excavation and Slips.

23. Excavation in excess of the authorized cross-section, as well as slides extending beyond the slope lines, shall not be paid for unless such are due to causes which are not under the control of the contractor or his agents. In all cases the surplus material shall be removed by the contractor without delay and the slopes reformed. The classification of the material shall be in accordance with its condition at the time of removal, regardless of prior conditions.

Disposal of Excess Excavation.

24. Where the quantity of excavation exceeds that required to make the embankments to standard cross-section, the surplus shall be used to widen the embankments uniformly, along one or both sides, as may be directed, and no material shall be deposited in waste banks unless such waste be indicated either on the profiles or by written order.

Waste Banks.

25. Where wasting is ordered the material shall, if possible, be deposited below grade line, and under no circumstances shall the waste bank have its nearest edge within ..... (....) ft. of the slope stakes of the cutting.

Borrow Pits, Etc.

26. Where the quantity of excavation from the cuttings of standard cross-section is insufficient to form the embankments the deficiency shall be made up by widening the cuttings on one or both sides of the center line, as may be directed, and no material shall be taken from borrow pits, unless such borrow be indicated either on the profiles or by written order.

Approximate Quantities Shown.

27. The classification and quantities shown on the profile exhibited for distribution of material are approximate only, and shall in no way govern the final estimate. The company reserves the right to increase or diminish the quantities given without affecting the contract unit prices for the various parts of the work.

Reserving Gravel, Etc.

28. Where gravel, stone or any other material suitable for special use of the company is met within the excavations, the same shall, when required, be reserved and deposited in convenient places on the right-of-way, as directed, and other suitable material in the vicinity substituted, as required to complete the embankments.

Berme in Rock Cuttings.

29. A berme of ..... (....) ft. shall be left between the top of slope of rock cuttings and toe of slope of the overlying earth.

Intercepting Ditches.

30. Intercepting ditches when ordered shall be made at the top of the slopes of all cuttings where the ground falls toward the top of the slopes, and they must diverge sufficiently to prevent erosion of the adjoining embankment. The cross-section and location of such ditches shall be designated and, if required, they shall be made in advance of opening the cutting.

Ditches in Cuttings.

31. Ditches shall be formed at the bottom of the slopes in cuttings according to the cross-section shown upon the plans, or such modifications thereof as may be directed; they shall be neatly made, clear of obstructions, and at the lower end must diverge sufficiently to prevent erosion of the adjoining embankment.

Subdrains.

32. Subdrains of tile shall be constructed of the size and location as directed. Trenches for these drains must be taken out at least .... (....) in. below frost line; the tiles shall be laid on a bed which shall be true, with half round section, with a filling of at least ..... (....) in. of cinders or other suitable material on either side and above the tile, and then covered with ordinary soil to the top of the trench.

Measurement and payment for such drains shall be by the linear foot, according to the diameter of tile, including excavation and refilling; the contractor to furnish all material.

Unsuitable Material.

33. Excavations incident to the construction of the roadbed, ditches, channels and roadways shall be used in forming the embankments; but no frozen or other unsuitable material shall be allowed to enter into their composition.

Formation in Layers.

34. When directed, embankments shall be built in horizontal layers of ..... (...:) ft. in thickness; these layers to be of the full width of the embankment and built to the true slope, and not widened with loose material from the top. The most suitable material shall in all cases be reserved for finishing the surface and no large stones shall be allowed within a depth of at least ..... (....) ft. below subgrade.

Shrinkage, Etc.

35. Embankments shall be carried to such height above subgrade and to such increased width as may be deemed a necessary provision for shrinkage, compression and washing. As the embankments become consolidated their sides shall be carefully trimmed to the proper slopes, and they must be maintained to their proper height, dimensions and shape until the work is finally accepted.

Embankments on Slopes.

36. When an embankment is to be placed on sloping ground the surface shall be deeply plowed or stepped; and, whenever directed,

boggy or unsuitable material shall be excavated so that the embankment shall be started from a firm foundation.

Embankments Across Swamps.

37. In crossing bogs or swamps of unsound bottom, a special substructure of logs and brushwood may be required, the logs forming this foundation to be not less than six (6) in. in diameter at the small end. If necessary there shall be two or more layers crossing each other at right angles, the logs of each layer being placed close together, with broken joints, and covered closely with brush; the bottom layer shall be placed transversely to the roadway and project at least five (5) ft. beyond the slope stakes of the embankment.

Measurement of this substructure and payment for the same shall be by units of one hundred (100) ft. square or fraction thereof of area covered by each layer.

Filling Trestles.

38. In forming embankments from trestles, the material shall be thoroughly compacted between the trestle bents and around and under all parts of the structure, and in case of train filling by means of a temporary trestle the material shall be uniformly spread in the fill.

Embankments at Trestles.

39. Embankments abutting the ends of trestle bridges shall be brought forward upon the structure a distance of at least ..... (....) ft., with an increased width of ..... (....) ft. in order to form a full roadbed.

Finishing Subgrade.

40. The subgrade shall be compact and finished to a true plane, and no depression left that will hold water.

Embankments Over Masonry, Etc.

41. In embankments over or about masonry or other structures the material shall be deposited in thin layers and each layer carefully tamped. Special care must be exercised not to unduly strain these structures, and only the best material shall be allowed for the purpose of such filling. The contract price for excavation shall cover the cost of obtaining, distributing and packing the material behind, over and around all such structures.

BORROW PITS.

Land Provided.

42. Land for borrow pits or waste banks shall be provided by the railroad company.

Drainage.

43. Borrow pits shall be connected with ditches and drained to the nearest water course, when required. Unless directed, material shall not be borrowed to a depth that will not permit of proper drainage.

Slopes and Bermes.

44. Side slopes of borrow pits on the right-of-way shall be the same as used in the cross-section of the adjoining roadbed. A berme

of not less than ..... (....) ft. in width shall be left between slope stakes of the embankment and the edge of the borrow pit, and a berme of not less than ..... (....) ft. between the outside slope of the borrow pit and the right-of-way line. Bermes shall consist of the original unbroken ground.

Cross-sectioning of Pits, Etc.

45. Borrow pits shall not be excavated before they have been staked out, and borrowing must be done in regular shape in order to admit of ready and accurate measurement. No borrowing nor wasting of material will be allowed on land set apart for station grounds or for other special purposes except by written directions.

PRICE AND MEASUREMENT OF GRADING.

Basis.

46. All grading will be estimated and paid for by the cubic yard at the prices specified for the respective materials. Measurement shall be made in excavation only, except in cases hereinafter mentioned.

Work Included in Price.

47. The contract prices per cubic yard shall include the excavation of the material by any method whatever, the loading, transportation and the deposit of the same in the manner described by these specifications, and in the places designated, the plowing or benching of slopes, as well as all other expense incident to the work of grading.

Haul.

48. Unless otherwise specified, it is distinctly understood that the contract price per cubic yard covers any haul found necessary and that there shall be no allowance made for any so-termed overhaul.

Embankment Measurement.

49. If it be impracticable to measure borrowed material in excavation, it may be measured in embankment, using the cross-section notes of the embankment, and making a just and reasonable allowance for change in bulk, so that the quantities shall equal the excavation quantities as nearly as possible.

Borrow Classification.

50. There shall be no classification or allowance made for loose or solid rock in borrow pits unless specific written instructions are given to the contrary, it being the intent and meaning of these specifications that all borrowed material shall be classified and paid for as common excavation.

TUNNEL EXCAVATION.

Line, Grade and Cross-section.

51. Tunnels shall be excavated to the alinement, gradients and sections shown upon the plans, or to such modifications thereof as may be directed.

Bottom of Rock Tunnels.

52. In rock tunnels the material shall in all cases be taken out ..... (....) in. below subgrade and refilled to subgrade with approved material.

Blasting.

53. Blasting shall be done with all possible care so as not to damage the roof and sides, and all insecure pieces of rock beyond the standard cross-section shall be removed by the contractor.

Excess Excavation.

54. Excavation in excess of the authorized cross-section shall not be paid for.

Price to Include.

55. The price paid for tunnel excavation shall embrace the cost of removal of all materials between the outer faces of the portals, and shall include the loosening, loading, transportation and placing of the material in embankment or waste banks as directed; it shall also include whatever materials and labor are required for temporary props, supports and scaffolding for the safe prosecution of the work, as well as all expense of keeping the tunnel ventilated and free from water, oil or gas.

Niches or Recesses.

56. Niches or recesses for the protection and convenience of the railway employés shall be provided at designated intervals.

Shafts.

57. The location, number and dimensions of all shafts shall be determined and the excavation price for them shall cover all materials contained within the specified cross-section between the surface of the ground, and the connection of the shafts with the tunnel; said price shall also cover all material and labor for curbing and support of the sides of the shafts as may be required, the cost of keeping the shafts free of water or oil, as well as the cost of all pumping and hoisting machinery.

Wells or Sumps.

58. Wells or sumps within the tunnel necessary for its permanent drainage shall be made as directed and paid for at the same rate per cubic yard as for tunnel excavation.

Right-of-Way for Roads.

59. The contractor shall make all arrangements and be at the sole expense for any right-of-way necessary over the top of the tunnel for such roads between the ends of the tunnel as he may need, and all grading necessary for the same shall be done at his expense.

Haul.

60. The contract prices per cubic yard for tunnel and shaft excavation, respectively, cover any haul found necessary in placing the material where designated, and there shall be no allowance for any so-termed overhaul.

CLAUSES SPECIALLY APPLICABLE TO REVISION OF EXISTING LINE OR WIDENING FOR ADDITIONAL TRACK.

Safety of and Delay to Train Service.

61. The contractor shall arrange his work so that there will be no interference or delay in any manner with the train service of the company, and he shall be responsible for any damage to the company's

property caused by his acts or those of his employés. Whenever the work is liable to affect the movement or safety of trains, the method of doing such work shall first be submitted for approval, without which it shall not be commenced or prosecuted. If continuous detention occur to the train service, the company reserves the right to complete the work at the expense of the contractor after giving him written notice.

Precautions for Safety of Trains and Tracks.

62. Heavy blasting shall not be allowed close to the main tracks, nor shall the contractor be permitted to transport material along or between the company's tracks, except when properly authorized. Whenever the work as authorized affects the safety of the trains or tracks the company shall take such precautions as it may deem advisable to ensure safety, and the cost of so doing shall be charged to the contractor and deducted from his estimate.

When and How Company's Tracks May Be Moved.

63. The contractor shall not move or in any way interfere with the company's tracks under any circumstances. Whenever it becomes necessary that the main line or side tracks be moved, it shall be done by the company, and the actual cost thereof charged to the contractor and deducted from his estimate.

Location of Additional Track.

64. The location of the additional track shall be on the ..... side of existing line, but whenever it is expedient to change any portion to the opposite side, the altered alinement shall be shown upon the maps or diagrams furnished by the company, and the contractor shall conform to the same without extra charge.

Plowing Slopes.

65. Whenever the existing embankment of ..... (....) ft. in height or over is raised or widened, the slope of the existing embankment shall be deeply plowed in order to bind the new material thoroughly to it.

Crossings.

66. Whenever it is necessary for material of any description to be transported across the existing track or tracks, the location of the crossings must be approved. The material and labor of placing and maintaining the same shall be furnished by the company and the actual cost charged to the contractor and deducted from his estimate.

Watchmen, Operators and Flagmen.

67. Watchmen, both day and night, shall be furnished by the company at the places it may consider necessary for the safety of the company's trains and works, and the cost shall be charged to the contractor and deducted from his estimate. It is distinctly understood, however, that the providing of such watchmen shall not relieve the contractor from the liability and payment for damages caused by his operations.

Safety Signals.

68. The cost of installment, maintenance and operation of all sig-

nals necessary to ensure the safety of trains, consequent upon the contractor's work, shall be borne by the contractor, and all instructions regarding their observance shall be strictly obeyed by him.

GENERAL CONDITIONS.

Temporary Fences.

69. Previous to or during the work of grading, the contractor, if directed, shall erect and maintain temporary fences in order to prevent trespass upon the railway or damage to adjoining property.

Crossings, Damage to Property, Etc.

70. The contractor shall, at his own expense, make and keep in good condition commodious passing places for public and private roads traversed by the line of railway, and shall be held responsible for damages of whatsoever nature to persons or neighboring property caused by workmen in his employ leaving gates or fences open, blasting rocks, building fires or in other ways, and, if necessary, payment of the estimate may be withheld until such damages are satisfactorily settled for, the intention of the contract being that the company shall not be held responsible for any claims or losses incurred during the construction of the line, due to the operations or negligence of the contractor or his employés.

Changes of Alinement or Gradients, Etc.

71. The alinement, gradients and cross-sections of the roadbed, as well as ditches and other incidental work, may be altered in part or in whole as deemed necessary either before or after the commencement of the work; but any such change or alteration shall not affect the unit prices specified in the contract, nor shall any such changes or alteration constitute a claim for damages, nor shall any claim be made or allowed on account of such change or alteration.

Work to Be Paid for as Extra.

72. The contractor shall be paid at contract unit rates only for work actually done, excepting in cases of cuttings or embankments, where the slopes have actually been completed and accepted.

Snow and Ice.

73. Before beginning grading, as well as during the progress of the work, the contractor shall remove all snow and ice from between the slope stakes at his own expense.

Bench Marks and Stakes.

74. The contractor shall carefully preserve all bench marks and stakes, and in case of neglect to do so will be charged with the resulting expense.

Roads.

75. Whenever required the contractor shall open up a safe road for passage on horseback and foot along the whole or any portions of the work under contract.

Temporary Roads, Trestles, Etc.

76. No allowance or compensation whatever shall be due or paid to the contractor for any temporary roads, bridges or trestles he may make to facilitate the work.

Final Clearing Up.

77. Before the work is finally accepted the contractor shall at his own expense clear away from the company's property, as well as from public and private roads and the channels of streams and ditches, all rubbish and surplus blasted or excavated material.

Extra Work.

78. The cost of any extra work shall not be considered or allowed unless such extra work shall have been done by direction in writing, and such written directions shall in every case contain the rates and methods of payment for said extra work.

Contractor's Risk.

79. The contractor shall take all risks from casualties of every nature and shall not be entitled to any compensation for detentions from such causes. All stock, tools and machinery employed on the work by the contractor are at his risk while on the property of the railroad company, and the contractor agrees to make no claim for injury or damage to same which may be caused by the operation of the railroad.

Company Defined.

80. Whenever the word "Company" is used in these specifications it designates the ..... Company.

Contractor Defined.

81. The word "Contractor" is used herein to designate the person or persons undertaking the work referred to in these specifications and drawings.

Work in Charge of

82. In the foregoing specifications it is understood and agreed that the Chief Engineer of the ..... Company is in charge of the work, and he may appoint such assistants as he may select. Whenever the specifications refer to the judgment, direction, decision, approval, etc., of an employé of the ..... Company, they designate and mean that the Chief Engineer or one of his assistants is intended and referred to. The decision of the Chief Engineer shall be final as to the intent and meaning of these specifications.

Specifications Part of Contract.

83. The specifications and general conditions referred to are distinctly understood as being embodied with the contract, the whole forming the entire agreement between the Company and the Contractor.

*SPECIFICATIONS FOR THE CONSTRUCTION OF ROADWAY.

ALTERNATE OPTIONAL OVERHAUL CLAUSE.

The following alternate optional overhaul clause is recommended to be substituted for clause No. 48 of the Specifications for the Formation of the Roadway in all cases where it is desired to allow overhaul:

48-a. No payment shall be made for hauling material when the length of haul does not exceed the limit of free haul, which shall be ..... ft.

The limits of free haul shall be determined by fixing on the profile two points—one on each side of the neutral grade point—one in excavation and the other in embankment, such that the distance between them shall equal the specified free-haul limit and the included quantities of excavation and embankment balance. All haul on material beyond this free-haul limit shall be estimated and paid for on the basis of the following method of computation, viz.:

All material within this limit of free haul shall be eliminated from further consideration.

The distance between the center of gravity of the remaining mass of excavation and center of gravity of the resulting embankment, less the limit of free haul as above described, shall be the length of overhaul, and the compensation to be rendered therefor shall be determined by multiplying the yardage in the remaining mass as above described by the length of the overhaul. Payment of the same shall be by units of one cubic yard hauled one hundred (100) ft.

When material is obtained from borrow pits along the embankment and runways are constructed, the haul shall be determined by the distance the team necessarily travels. The overhaul on material thus hauled shall be determined by multiplying the yardage so hauled by one-half the round distance made by the team less the free-haul distance. The runways shall be established by the engineer.

†GENERAL SPECIFICATIONS FOR A MODERN STEAM SHOVEL FOR ROADWAY CONSTRUCTION.

RECOMMENDED GENERAL REQUIREMENTS.

Three important cardinal points should be given careful attention in the selection of a steam shovel. These are in their order:

* Vol. 7, 1906, pp. 444-446, adopted by letter ballot, June, 1906; Vol. 8, 1907, pp. 297, 313.

† Adopted, Vol. 8, 1907, pp. 298-302, 343-346.

(1) Care in the selection, inspection and acceptance of all material that enters into every part of the machine.

(2) Design for strength.

(3) Design for production.

GENERAL SPECIFICATIONS.

Weight of shovel: Seventy (70) tons.

Capacity of dipper: Two and one-half (2½) yards.

Steam pressure: One hundred and twenty (120) lbs.

Clear height above rail of shovel track at which dipper should unload: Sixteen (16) ft.

Depth below rail of shovel track at which dipper should dig: Four (4) ft.

Number of movements of dipper per minute from time of entering bank to entering bank: Three (3).

Character of hoist: Cable.

Character of swing: Cable.

Character of housing: Permanent for all employés.

Capacity of tank: Two thousand (2,000) gallons.

Capacity of coal bunker: Four (4) tons.

Spread of jack arm: Eighteen (18) ft. A special short arm should be provided.

Form of steam shovel track: "T" rails on ties.

Length of rails for ordinary work: Six (6) ft.

Form of rail joint: Strap.

REPAIR PARTS NECESSARY TO CARRY.

1 Hoisting cable,
1 Thrusting cable,
1 Swinging engine cable,
1 Set dipper teeth,
1 Dipper latch,
Duplicate of each sheave on machine.
12 Cold shunts,
6 Cable clamps,
1 U bolt,
Lot assorted bolts and nuts,
Lot assorted pipes and fittings,
Lot assorted waterglasses.

REPAIR TOOLS NECESSARY TO CARRY.

1 Blacksmith Forge with Anvil and complete tools,
1 Small Bench Vise,
3 Pipe Wrenches, assorted sizes,
3 Monkey Wrenches, assorted sizes,
6 Chilson Wrenches, assorted sizes,
1 Ratchet with assorted Twist Drills,
6 Round Files, assorted sizes,
1 Hack-saw, with twelve blades,
1 Set Pipe Taps and Dies,
1 Set Bolt Taps and Dies,
6 Cold Chisels, assorted sizes,
2 Machinists' Hammers,
2 Sledges,
2 Switch Chains,
2 Re-railing Frogs,
2 Ball-Bearing Jacks,
1 Siphon, complete,
1 Axe,
1 Hand Saw,
1 Set Triple Blocks, with rope,
2 Lining Bars,
1 Pinch Bar,
6 Shovels,
6 Picks,
1 Coal Scoop,
1 Flue Cleaner,
1 Fire Hoe,
1 Clinker Hook,
1 Slash Bar,
2 Hand Lanterns,
2 Torches,
Assortment of Packing,
Assorted Oil, in cans.

*METHODS OF HANDLING STEAM SHOVEL WORK.

RECOMMENDED PRINCIPLES OF PRACTICE.

Gage of track for dump cars: Standard.

Style and capacity of cars for cut under six feet, haul less than one mile: Six (6) yard dump car.

Style and capacity of cars for cut under six feet, haul one to six miles or over: Standard car with permanent sides, with swinging hinged doors, and cars connected by aprons.

* Adopted, Vol. 8, 1907, pp. 302-306, 346-349, 350.

Style and capacity of cars for cut over six feet, haul less than one mile: Six (6) yard dump car.

Style and capacity of cars for cut over six feet, haul one to six miles or over: Standard car with permanent sides, with swinging hinged doors, and cars connected by aprons.

Points to be observed in the selection of flat cars for steam shovel work:

(1) Car should be strong enough for the purpose;

(2) Brake-wheels should be in good condition, and in case material is to be plowed off, these should be placed at side of car;

(3) Stake pockets should be in good condition and not spaced too far apart. Four feet apart in center of car and closer at ends is good practice;

(4) Stakes should be strong enough to prevent accident or derailment of plow.

Where dirt is dumped from trestle in fill for haul less than two miles, light cars and light trestles are recommended.

For handling unloading plows, a cable with an auxiliary engine and drum is recommended. The machine should be able to develop sixty (60) ton pull, and weigh about 28 tons; steam cylinders, 12 in. x 12 in.; diameter of drum, 4½ ft., permitting four wraps of 1½ in. cable to be made.

When raising track, the center plow is recommended when raise is light; side plows are recommended for making heavy fills.

A strong plow with trailer is recommended; it should be not less than four and one-half (4½) ft. high and thirty-six (36) ft. in length over all.

Weight of plow: Seven (7) tons.

Size and length of cable: One and one-half (1½) in. in diameter and 1,200 ft. in length.

Form of spreader: Two-arm.

Method of handling spreader: Air.

Spread of wings: Twenty (20) ft.

Limiting angle of wings: Forty-five (45) degrees.

Height above rail at which spreader should deposit material: Two (2) ft.

Depth below rail at which spreader should work: Two (2) ft.

In making embankments with trains on new location the following vertical limits are recommended for the respective conditions:

(1) For raising track with material dumped: Four (4) ft.

(2) For a central core put up by teams and widened with shovel material: not to exceed four (4) ft.

(3) For temporary filling trestle: Under ordinary circumstances, temporary trestle for fills over four (4) ft. in height.

In making embankments with trains in present location of track under traffic, under ordinary circumstances, where sand, gravel or cinders can be used, it is economical to jack main track vertically in place where raise is not to exceed four (4) ft.

Where traffic is heavy, a temporary track on one side to carry the traffic and main track jacked in place vertically is recommended where track is to be raised to exceed four (4) ft.

Where raise of track is to exceed six (6) ft., it is economical to throw main track to one side and build trestle.

*ALLOWANCE FOR SHRINKAGE IN EMBANKMENTS.

RECOMMENDED PRINCIPLES OF PRACTICE.

For green embankments, shrinkage allowance should be made for both height and width.

The shrinkage allowance should be as follows: For black dirt, trestle filling: Fifteen per cent. (15%).

For black dirt, raising under traffic: Five per cent. (5%).

For clay, trestle filling: Ten per cent. (10%).

For clay, raising under traffic: Five per cent. (5%).

For sand, trestle filling: Six per cent. (6%).

For sand, raising under traffic: Five per cent. (5%).

†STEAM SHOVEL REPORT BLANKS.

RECOMMENDED STANDARD FORMS.

Three blank forms are recommended for reporting results of steam shovel work:

Form M. W. 1100. Daily Steam Shovel Report.

Form M. W. 1101. Monthly Steam Shovel Report.

Form M. W. 1102. Record of Steam Shovel Work.

* Adopted, Vol. 8, 1907, pp. 307, 308, 349, 350.

† Adopted, Vol. 8, pp. 309-311, 349.

Size 8x13 inches

Form M.W. 1100

A. B. & C. R. R. Co.

DAILY STEAM SHOVEL REPORT

Steam Shovel No._____ at _____ 190__

Face of Bank_____ Average Length of Haul_____

DETAILS OF LABOR.

Steam Shovel Crew Commenced Work M

" " " Quit " M

	HOURS	RATE	AMOUNT
S. S. Engineer			
" Fireman			
" Cranesman			
" Watchman			
" Pitmen			
Car Repairers			
Laborers			
Pumpmen			
TOTAL			

Spotting Crew Commenced Work M

" " Quit " M

Engine No.			
" "			
" "			
Conductor			
Brakeman			
Engine Watchmen			
Superintendence, etc.			
TOTAL			
GRAND TOTAL			

CARS LOADED.

		CAPACITY IN YARDS	No. CARS	YDS. PER CAR	TOTAL YARDS
Hart Convert.	34' 80,000	35.6 side			
	34' 80,000	25.3 center			
Rodgers,	34' 100,000	29.3			
	34' 80,000	29.3			
	34' 40,000				
Haskell & Barker,	40' 80,000	36.20			
Ingoldsby,	42½' 100,000	42.4			
Flats	80,000	29.3			
	60,000	22			
	50,000	18.3			
	40,000	14.7			
Coal	60,000	36			
	50,000	32.5			
	40,000	23			
6 Yd. Dump Cars		6			
5 Yd. Dump Cars		5			
TOTAL					

Loads Left Over from Previous Day

Average Cost per Cubic Yard for Labor

" " " " " " Material

TOTAL Average Cost per Cubic Yard

SUPPLIES, LOCOMOTIVES, CARS, ETC.

	QTS.	PINTS	COST		QTS.	PINTS	COST
Valve Oil				Coal Loco.			
Engine Oil				Waste C. C.			
Car Oil				" Wool			
Signal Oil							
Headlight Oil							
Coal Shovel				TOTAL			

Kind of Material Handled

Character of Work Performed

Track Conditions

General Conditions

Weather

DELAYS

	HOURS	MIN.	Remarks
Waiting for Cars			
Moving Shovel			
Repairing "			
" Locomotive			
Other Delays			
TOTAL Delays			

_____ (Signature.)

Size 8x13 inches. Form M. W. 1101.

A. B. & C. R. R. Co.

MONTHLY STEAM SHOVEL REPORT.

Steam Shovel No.....at.....Month.....

Average Face of Bank.....Average Length of Haul.....

General:	
Number of Days Worked	
Average Daily Car Output	
Average Cubic Yards per Car	
Total Cubic Yards	
Average Cubic Yards per Day	
Actual Time Worked by Steam Shovel	
Time Delayed	
Percentage of Delays	
Number and Kind of Cars Used	
Number and Kind of Engines	
Kind of Material	
Character of Work Performed	
Track Conditions	
General Conditions	
Weather	

	Total.	Per Day.	Per Yard.
Labor:			
Cost Shovel Service			
Cost Train Service			
Cost Car Repairs			
Cost Dumping Cars			
Cost of Superintendence and Plant Rental			
TOTAL Cost Labor			

	Total Cost.	Used Per Day.	Cost Per Day.
Supplies:			
Valve Oil			
Engine Oil			
Car Oil			
Signal Oil			
Headlight Oil			
Coal for Shovel			
Coal for Engine			
Waste C. C. and Wool			
TOTAL Supplies			

	Per Yard.	Per Day.
Total:		
Total Cost Labor		
Total Cost Supplies		
Total Cost Steam Shovel Work		

Size 8x13 inches. Form M. W. 1102

A. B. & C. R. R. Co.

RECORD OF STEAM SHOVEL No.....

From.....M.....190...to.....M.....190...
Engineer..... Cranesman.....
Material.....Average Haul Stations.....
Locomotive No.....Cars No..... Size.....
Total Minutes Loading.....No. Cars.....Minutes Per Car.....No. Dippers.....
Seconds Per Dipper.....Approximate Yardage.....
Total Minutes Moving..... No. Moves..... Minutes Per Move.....
Minutes Delays Waiting for Cars..... Weather.....
Other Delays (Minutes).....General Conditions.....
Total Hours Worked.....Hours Lost..... Total Hours on Duty.....
Cause Hours Lost.....

Shovel Moved and Ready.	Shovel Began Loading.	Delays Waiting for Cars.	Finished Loading and Ready to Move.	Time Loading.	Cars.	Dippers.	Time Moving.	OTHER DELAYS.			Cause of Delay and Remarks.
								From	To		
Time.	Time.	Mins.	Time.	Mins.	No.	No.	Mins.	Time.	Time.	Mins.	
Totals											

.....
Inspector.

COMMITTEE NO. II.

BALLASTING.

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*BALLASTING.

DEFINITIONS.

BALLAST.—Selected material placed on the roadbed for the purpose of holding the track in line and surface.

BROKEN or CRUSHED STONE.—Stone broken by artificial means into small fragments of specified sizes.

CHATS.—Tailings from mills in which zinc and lead ores are separated from the rocks in which they occur.

GRAVEL.—Small worn fragments of rock, coarser than sand, occurring in natural deposits.

SAND.—Any hard, granular, comminuted rock material, finer than gravel, and coarser than dust.

CHERT.—An impure flint or hornstone, occurring in beds.

CINDERS.—The residue from the coal used in locomotives and other furnaces.

SLAG.—The waste product, in a more or less vitrified form, of furnaces for the reduction of ore; usually the product of a blast furnace.

BURNT CLAY.—A clay or gumbo which has been burned into material for ballast.

GUMBO.—A term commonly used for a peculiarly tenacious clay, containing no sand.

DISINTEGRATED GRANITE.—A natural deposit of granite formation, which, on removal from its bed by blasting or otherwise, breaks into particles of size suitable for ballast.

†BALLASTING.

GENERAL CONCLUSIONS.

While there is great variation in the qualities of the different natural materials for ballast, the choice of these qualities is not usually left

* Adopted, Vol. 5, 1904, pp. 486, 495, 498-501; Vol. 6, 1905, pp. 736, 745; Vol. 7, 1906, pp. 83, 84, 88, 100.

† Adopted, Vol. 5, 1904, pp. 494, 495, 513, 514; Vol. 6, 1905, pp. 736, 737.

to the engineer, but has been made already by nature, and all that is left to decide is what is most available or most expedient. This each one must decide for himself in the light of his own circumstances. The question of finance may be a ruling consideration or there may be but one thing to be had, and he must take that or nothing.

In the case of crushed rock, however, the process of manufacture being under control, it is practicable to make the product conform to specifications.

*STONE BALLAST.

RECOMMENDED SPECIFICATIONS.

1. *Quality.*—(a) Stone shall be durable enough to resist the disintegrating influences of the climate where it is used.

(b) It shall be hard enough to prevent pulverizing under the treatment to which it is subjected.

(c) It shall break in angular pieces when crushed.

2. *Size.*—(a) The maximum size of ballast shall not exceed pieces which will pass through a screen having 2-in. holes.

(b) The minimum size shall not pass through a screen having ¾-in. holes.

†GRAVEL, CINDERS AND BURNT CLAY BALLAST.

RECOMMENDED PRINCIPLES OF PRACTICE.

GRAVEL.—Gravel should be screened or washed where prevention of dust is an object, but this need not be done where the character of traffic is such that dust is not particularly objectionable. It is recommended that gravel be screened or washed where the proportion of sand or clay exceeds fifty per cent. The minimum size should be such as is retained on screens of 12 meshes per in. By this is meant the size pebble that would be retained in a thorough, careful test.

CINDERS.—The use of cinders as ballast is recommended for the following situations: On branch lines with a light traffic; on sidings and yard tracks near point of production; as sub-ballast in wet, spongy places; in cuts and on fills; as sub-ballast on new work where dumps are settling, and at places where the track heaves from frost. It is

* Adopted, Vol. 5, 1904, pp. 487, 495, 501-505; Vol. 6, 1905, pp. 737, 745.

† Adopted, Vol. 6, 1905, pp. 737, 738, 745, 746; Vol. 7, 1906, pp. 84, 85, 90, 91, 92, 100.

recommended that provision be made for wetting down cinders immediately after being drawn.

BURNT CLAY.—The material should be black gumbo or other suitable clay free from sand or silt. The suitability of the material should be determined by thorough testing in a small test kiln before establishing a ballast kiln.

The material should be burned hard and thoroughly.

The fuel used should be fresh and clean enough to burn with a clean fire. It is important that a sufficient supply be kept on hand to prevent interruption of the process of burning.

Burning should be done under the supervision of an experienced and competent burner.

Ballast should be allowed to cool before it is loaded out of the pit.

Absorption of water should not exceed fifteen per cent. by weight.

*BALLAST SECTIONS.

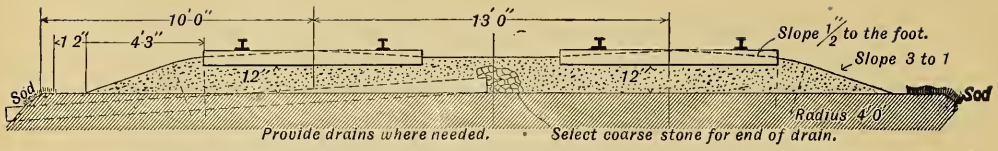
RECOMMENDED PRACTICE.

The following ballast sections are recommended as good practice:

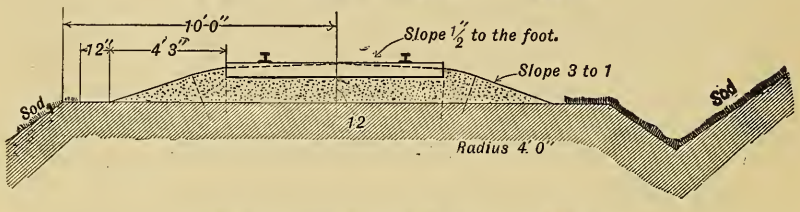
The sections for Class A track are intended to show minimum depth under ties and are recommended for use only on the firmest, most substantial and well-drained sub-grades.

The sodding of the roadbed shoulder next to ditch and of the slopes of the ditch are recommended.

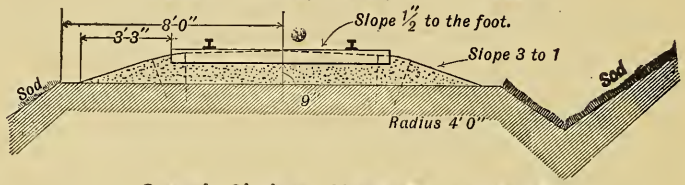
* Adopted, Vol. 8, 1907, pp. 44-46, 62, 65, 66, 67.



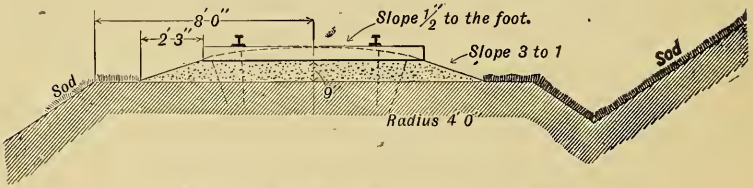
Gravel, Cinders, Chats, Etc.—Class A.



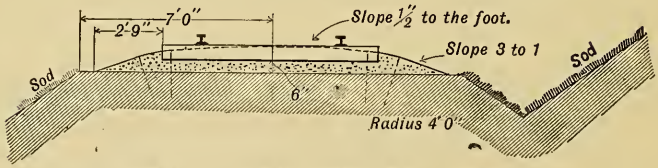
Gravel, Cinders, Chats, Etc.—Class A.



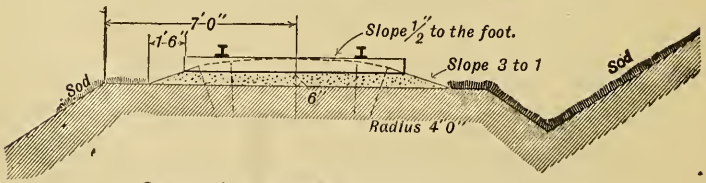
Gravel, Cinders, Chats, Etc.—Class B.



Cementing Gravel and Chert.—Class B.



Gravel, Cinders, Chats, Etc.—Class C.



Cementing Gravel and Chert.—Class C.

COMMITTEE NO. III.

TIES.

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*TIES.

DEFINITIONS.

Cross-Tie.—That transverse member of a railway track which supports the rails and by means of which they are retained in position.

Pole Tie.—A tie made from a tree of such size that not more than one tie can be made from a section. Such a tie generally shows sapwood on two sides.

Split Tie.—A tie made by splitting from a tree of such size that two or more ties can be made from a section.

Slab Tie.—A tie made from slabs.

Sawed Tie.—A tie having both faces and sides sawed.

Quartered Tie.—A tie made from a tree of such size that four ties only are made from a section.

Half-Round Tie.—A slabbed tie having greater width on lower than on top face.

Slabbed Tie.—A tie sawed on top and bottom only.

Hewed Tie.—A tie hewed on at least two sides.

Sap Tie.—A tie which shows more than a prescribed amount of sapwood in cross-section.

Heart Tie.—A tie showing sapwood on one or two corners only and which sapwood does not measure more than one inch on either corner, on lines drawn diagonally across the end of tie.

Strict Heart Tie.—A tie having no sapwood.

Wane Tie.—A squared tie showing part of the original surface of the tree on one or more corners.

Doty Tie.—A tie affected by fungous disease.

Pecky Tie.—A tie made from a cypress tree affected with a fungous disease, known locally as peck.

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* Adopted, Vol. 5, 1904, pp. 73, 74, 78, 106-120, 131, 132; Vol. 6, 1905, pp. 766, 767; Vol. 7, 1906, pp. 33, 37, 66.

TAPPED TIE.—A tie made from a tree, the resin or turpentine of which has been extracted before felling.

SCORE MARK.—A mark made by the ax as an aid in hewing.

SHAKES.—Separations of the wood fiber, due to the action of the wind.

CHECKS.—Small cracks in the wood due to seasoning.

FACE.—The upper or lower plane surface of a tie.

*FORMS FOR TIE RECORDS.

RECOMMENDED STANDARD FORMS.

Form 1, "Statistics of Cross-Tie Renewals," is intended for general statistical information concerning the life and cost of cross-ties in use on a division, regardless of the kinds of timber, except in a general way.

Form 1-A, "Comparison Between Different Kinds of Wood," is a more detailed comparison between the different kinds of woods and preservative processes, and will explain, in many cases, why the service of ties on one railroad is longer than on another.

Form 1-B, "Life Record of Ties," gives the life record of ties.

Form 1-C, "Statistics of Treated Ties," is intended to give full details concerning the preservation of cross-ties.

Form 1-D, "Report of Marked Ties Removed from Track," is recommended as the proper blank to be used by the Section Foreman for reporting the information required for form 1-B. This form can also be used for reporting any cross-tie removals when the ties are marked in such a way as to indicate the year laid.

REPORT OF MARKED TIES REMOVED FROM TRACK Form 1-D

On Section_____Subdivision_____During Month of_____190____

Removed From Main Tracks					Removed From Sidings				
Number Removed	Year Put In as Marked on Tie	Kind of		Cause of Removal	Number Removed	YearPut in as Marked on Tie	Kind of		Cause of Removal
		Timber	Treatment				Timber	Treatment	
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

This blank must be sent in monthly by all Foremen on whose sections treated ties have been used, whether any ties have been removed or not. When no ties have been removed, it must be so stated on the blank.

After approval by the Supervisor, it is to be forwarded to the Engineer Maintenance of Way (or other proper officer).

* Adopted, Vol. 3, 1902, pp. 102-105, 109-113.

FORM 1.

STATISTICS OF CROSS-TIE RENEWALS.

FORM 1-A.

COMPARISON BETWEEN DIFFERENT KINDS OF WOOD.

Form 1

STATISTICS OF CROSS-TIE RENEWALS

For Year ending _____ 19__

DIVISION (Report by Division and not by System.)	Miles of Road Operated		Average Gross Tonnage passing over Division in Year	Maximum Weight in Tons		Weight of Main Track Rail in lbs. per yard	*Percentage of Main Track				Kind of Ballast Used. Percentage of Each	Number of Ties in Each Mile of Track		Total Number of Ties Renewed During Year		Per Cent. of Renewals to Number in Tracks			Average Cost Ties Delivered on Ground of Division		*Total Cost of Tie Renewals Per Mile of Track			Average Life of Cross-Ties in			Kind of Timber Usedfor Tis. If Seeveral Kinds State rcentage Peof Each
	All Main Tracks	All Tracks Including Sidings		Locomotive and Tender	Fully Loaded Freight Car		Curved	Tie-Plated	Ballasted	Laid with Treated Ties		Main	Side	In Main Tracks	In Side Tracks	Main	Side	Total	Treated Ties	Untreated Ties	All Main Tracks	All Side Tracks	All Tracks	Main Tracks	Side Tracks	All Tracks	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Total for Year																											
Total for Previous Year																											

*To include cost of cross and switch ties, tie-plates, and spike plugs, but not the labor of placing in track.
Omit mileage of new tracks in which tie renewals have not been commenced, and omit number of ties used for new tracks.
Tons of 2,000 lbs. to be used.
Data for columns 25, 26 and 27 kept on Form 1-B.
Data for column 28 given more in detail on Form 1-A.
Bridge ties are to be considered as track ties and included in report.

Form 1—A

COMPARISON BETWEEN DIFFERENT KINDS OF WOOD

For Year Ending _____ 19__

DIVISION (Report by Division and not by System.)	UNTREATED																		TREATED												GRAND TOTALS			No. of tie-plated ties included in totals
	White Oak, Burr Oak, Chestnut Oak			Chestnut			Pine			Cedar			Cypress			Totals			Creosoted			Burnettized			Zinc Tannin			Total							
	Total in all Tracks	Total Ties Removed	Per Cent. of Renewals	Total in all Tracks	Total Ties Removed	Per Cent. of Renewals to Total	Total in all Tracks	Total Ties Removed	Per Cent. of Renewals to Total	Total in all Tracks	Total Ties Removed	Per Cent. of Renewals to Total	Total in all Tracks	Total Ties Removed	Per Cent. of Renewals to Total	Total in all Tracks	Total Ties Removed	Per Cent. of Renewals to Total	Total in all Tracks	Total Ties Removed	Per Cent. of Renewals to Total	Total in all Tracks	Total Ties Removed	Per Cent. of Renewals to Total	Total in all Tracks	Total Ties Removed	Per Cent. of Renewals to Total	Total in all Tracks	Total Ties Removed	Per Cent. of Renewals to Total	Total in all Tracks	Total Ties Removed	Per Cent. of Renewals to Total	
1	2		4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
Totals																																		

This blank elaborates the information in column 28 of Form 1, and compares the value of the different woods as ties, irrespective of cost.
Do not include ties in new tracks in which renewals have not yet commenced.
See Form 1-C for detail information concerning "preserved" or "treated" ties.
If the headings given do not cover your ties, change them.

FORM 1-B.

LIFE RECORD OF TIES.

FORM 1-C.

STATISTICS OF TREATED TIES.

Form 1—B

LIFE RECORD OF TIES——————RAIL——————

Data completed to——————19——

Year	Total Number of Cross-Ties of all kinds laid in tracks (inc. new tracks)		Total Number of the Cross-Ties Stamped of the Year in Column 1 Removed From Tracks in the Year in Columns 4 to 23 (both inclusive).																				Per cent. remaining in track on date of this report		Average Life in years deduced from renewals	
			1894		1895		1896		1897		1898		1899		1900		1901		1902		1903		Total Removed					
	Main	Side	Main	Side	Main	Side	Main	Side	Main	Side	Main	Side	Main	Side	Main	Side	Main	Side	Main	Side	Main	Side	Main	Side	Main	Side
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
1888																												
1889																												
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1905																												
1906																												
1907																												
1908																												

This blank cannot be tabulated for several Divisions or Railroads. It must be presented for each separately, but will only be printed when considered by the Committee sufficiently complete. When records have not been kept so that this can be filled out for a single year, the member should return it to the Secretary marked "No Data." In course of time it will be a valuable blank to all, and will be easily kept when once started.

This blank furnishes the data for columns 25, 26 and 27 of Form 1.

Explain in body of blank causes for increased or decreased life of ties as years advance.

State in body of blank kinds of timber used for ties and approximate percentage of each kind.

Form 1—C

STATISTICS OF TREATED TIES

For Year Ending——————19——

DIVISION (Report by Division and not by System.)	LIFE OF TREATED TIES IN YEARS																						Antiseptic Used	Amount Injected per Cubic Foot	Number of Treated Ties in Track this date	Number put in Tracks this Year	Average Cost per Tie				Remarks
	Pine				Hemlock				Beech				Spruce																		
	NAME OF PROCESS																										First Cost Untreated	For Extra Handling and Transportation	For Preservative Treatment	Ready for Track	
	Creosote	Burnett-izing	Zinc Tannin		Creosote	Burnett-izing	Zinc Tannin		Creosote	Burnett-izing	Zinc Tannin		Creosote	Burnett-izing	Zinc Tannin		Creosote	Burnett-izing	Zinc Tannin												
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34

The life record of treated ties should be kept by members separately on a blank like Form 1-B.

*SPECIFICATIONS FOR TIES.

RECOMMENDED STANDARD SPECIFICATIONS.

Woods to Be Used Untreated.

1. The following woods may be used for tie timber without any preservative treatment:

White Oak family.
Long-leaf strict heart yellow pine.
Cypress, excepting the white cypress.
Redwood.
White Cedar.
Chestnut.
Catalpa.
Locust, except the honey locust.
Walnut.
Black Cherry.

Woods to Be Treated.

2. The following woods shall preferably not be used for tie timber without a preservative treatment approved by the purchaser:

Red Oak family.
Beech.
Elm.
Maple.
Gum.
Loblolly, short-leaf, lodgepole, Western yellow pine, Norway, North Carolina pine and other sap pines.
Red Fir.
Spruce.
Hemlock.
Tamarack.

Material and Manufacture.

3. All ties shall be well and smoothly hewed or sawed out of straight, growing timber of specified dimensions and out of wind, sawed ends, with straight and parallel faces, the minimum width of either face to be not less than that given in the table of dimensions. All ties shall have bark entirely removed before being delivered on the company's ground. Ties shall be free from splits, shakes, loose or decayed knots, or any other imperfections which may impair their strength or durability.

DIMENSIONS.

Dimensions.

4. Except in pole ties with rounded sides, or in half-round ties, none shall be less than eight (8) in. width of face, and in no tie shall the thickness be less than six (6) in. A variation in size will be permitted of one-half (½) in. over in thickness, two (2) in. over in width and one (1) in. over in length.

* Adopted, Vol. 5, 1904, pp. 72, 73, 78, 120-132; Vol. 6, 1905, pp. 763-766; Vol. 7, 1906, pp. 34-36, 65, 66.

Allowable Variation in Pole Ties.

5. In pole ties with rounded sides and half-round ties, the width of face may be less than that given in the table of dimensions, but the least area of cross-section shall be not less than the area corresponding to the tabular dimensions, and in no case shall the width of face be less than six (6) in.

TABLE OF DIMENSIONS.

Class.	Thickness by Width of Face.	Length.		
	Inches.	Feet.	Feet.	Feet.
A	7 x 10	8	8½	9
B	7 x 9	8	8½	9
C	7 x 8	8	8½	9
D	6 x 9	8	8½	9
E	6 x 8	8	8½	9

Piling Untreated Ties.

6. Ties which are to be delivered along the right-of-way of the railroad shall be piled at station yards or at points between stations designated in the contract, not less than ten (10) ft. from the nearest rail; each pile to be of either 25 or 50 ties, built with two ties on the ground and above in alternate courses of 7 and 2, except the top, which

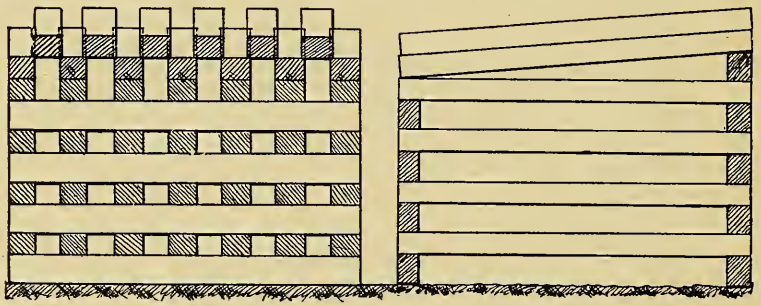

FIG. 1.—PILING DIAGRAM FOR FIFTY TIES.

shall be placed to form a watershed, as shown in diagram. Each pile shall be plainly marked with the owner's name and date when piled. Three feet of space shall be left between piles to allow easy inspection. Sawed ties shall be piled separately from hewed ties.

Removal of Rejected Ties.

7. All rejected ties shall be removed from the company's right-of-way within ten days after notice is given.

Piling Treated Ties.

8. Ties treated with a water solution, like zinc-chloride, particularly red oak and beech ties, shall be piled in close piles on well-drained ground, to prevent checking.

Time of Cutting.

9. Ties shall be cut, as far as possible, in the winter period; that is, from October to March.

*SPECIFICATIONS FOR DATING NAIL.

RECOMMENDED STANDARD SPECIFICATIONS.

Material. 1. The nail shall be ¼-in. in diameter, 2½-in. in length, with head ⅝-in. in diameter, having stamped therein two figures designating the year; the figures to be ⅜-in. in length and depressed into the head 1/16-in., made of iron or steel, galvanized with a coating of zinc, evenly and uniformly applied, so that it will adhere firmly to the surface of the steel.

Test. 2. Any specimen shall be capable of withstanding the following test: The sample shall be immersed in a standard solution of copper sulphate for one minute and then removed, immediately washed in water thoroughly, and wiped dry. This process shall be repeated. If after the fourth immersion there is a copper-colored deposit on the sample, or the zinc has been removed, the lot from which the sample was taken shall be rejected.

Chemicals. 3. The standard solution of copper sulphate shall consist of a solution of 34.5 parts of crystallized copper sulphate in 100 parts of water. This solution shall have a specific gravity of 1.185 at 70 degrees Fahrenheit. While a sample is being tested, the temperature of the standard solution shall at no time be less than 60 degrees Fahrenheit nor more than 70 degrees Fahrenheit.

†RULES FOR TIE RECORDS.

RECOMMENDED PRACTICE.

Section foremen should be provided with daily record blanks having space for each day of the month to record the number of treated ties put into track that day and the number taken out the same day, the latter being according to the cause necessitating their removal, whether rotten, broken, burned or rail cut. They should also show the year in which these ties were treated as indicated by the stamp and by the dating nail. The section foreman should make these records each day, and at the end of each month the daily record should be forwarded to the proper superior officer. If no treated ties have been taken out or put into track during the month, section foreman should so note on report.

Treated ties already in track, but taken up and relaid on another part of the same section, should not be inserted on this report as ties taken out or put in.

* Adopted, Vol. 7, 1906, pp. 37, 67.
† Adopted, Vol. 7, 1906, pp. 38, 67, 68.

Section foremen should see that a dating nail is driven in the upper side of every treated tie when it is first laid in the track, about ten inches inside of the rail, and on the line side of the track. The tie should be laid with the end having the year stamped on it on the line side of the track. A supply of these nails should be carried on the hand-car whenever any ties are to be laid, and dating nails driven the same day the tie is put in.

Section foremen should be especially careful to see that neither they nor their men injure or destroy the marks or nails intended to identify the ties.

At the end of each year all dating nails for that year remaining on hand and unused should be returned to the storekeeper, and requisition made for a new supply stamped with the following year.

It is recommended that, in addition to the use of the dating nail, each tie be stamped at the treating plant, before treatment, with the year; and, preferably, be stamped on both ends.

*SPECIFICATIONS FOR TIE TREATMENT.

RECOMMENDED STANDARD SPECIFICATIONS.

†GENERAL REQUIREMENTS.

Ties shall not be treated earlier than 90 days after cutting and piling in open spaces to season, if of pine; or 120 days if of oak; and for other timbers for such period as is necessary to bring them to a corresponding degree of seasoning. If this is done prior to receipt at the treating works, ties may be loaded direct from the cars to the trains; otherwise they shall be unloaded on the ground, stacked in piles eight (8) ft. square, with two ties only in bottom layer and two and seven in every alternate layer, except the top one, which shall be laid close with an extra tie under one end to form a rain shed. The outside ties in each layer shall be placed on edge to provide an air space above each layer. The piles shall be placed ten (10) ft. centers in one direction and nine (9) ft. centers in the other direction. When so stacked, ties shall be allowed to season for a time at least sufficient to make up the 90 and 120 days required, or other time necessary to thoroughly air season. Ties treated in the same run shall be as nearly as possible

* Adopted, Vol. 8, 1907, pp. 476-480, 520.

† The General Requirements apply to each of the following treatments. If used in specifications for the purchase of ties or for treatment, then these General Requirements should be followed only by the particular treatment desired.

uniform in kind and degree of seasoning. No ties shall be put into the cylinder which do not conform to the requirements of the tie specifications as to shakes, checks, etc. All ties which show signs of checking shall be provided with some means for preventing further checking, either by means of "S" irons, bolts, or other device, in order to prevent further checking during and after treatment, which would be liable to render the tie worthless. Where ties are to be adzed or bored for subsequent insertion of tie-plates or screw spikes, such adzing and boring shall in all cases be done before treatment.

When in condition to treat, the ties shall be placed in the cylinders, the door closed and live steam admitted at such rate as to secure 20 lbs. of steam pressure within 30 to 50 minutes, as shown by gage connected to the cylinder. This pressure shall be maintained for periods varying from one to five hours, depending upon the character of the timber and its condition; but the pressure as indicated on the gage shall at no time be allowed to exceed 20 lbs. Where the timber is absolutely air-seasoned and it is possible to secure the desired penetration without steaming, this may be omitted entirely, subject to the approval of the purchaser. During the time of steaming a vent shall be kept open in the bottom of the cylinder or in the drain therefrom to permit the escape of air and the condensed water in the cylinder.

When the steaming is completed the steam shall be blown off, and a vacuum of not less than 24 in. of mercury produced, if the works are located at sea level, or a corresponding degree of vacuum produced at higher altitude.

ZINC CHLORIDE TREATMENT.

This vacuum shall be maintained for at least one-half hour, at the expiration of which time zinc chloride shall be admitted without otherwise breaking the vacuum; a pressure of 100 lbs. per sq. in. applied, and maintained until the desired absorption is obtained. The amount of solution injected shall be equivalent to ½-lb. of dry soluble zinc chloride per cubic foot of timber. The solution shall be as weak as can be used, and still obtain the desired absorption of zinc chloride, and shall not be stronger than 5 per cent. The solution shall be heated to a temperature of not less than 140 degrees before admission to the cylinder. If the cylinders are provided with steam coils, steam pressure shall be maintained in these coils during treatment.

The zinc chloride used shall be as free from any impurities of any kind as is practicable, being slightly basic, absolutely free from free acid,

containing not more than $\frac{25}{1000}$ of 1 per cent. of iron. The amount of chloride specified to be injected shall be of soluble zinc chloride only. The amount of solution absorbed shall be determined by calculation based on the gage readings of the tank holding the supply of solution. The strength of the zinc-chloride solution shall be carefully controlled from time to time by hydrometer readings. Borings shall be taken from time to time from at least six ties treated in the same run, and a determination of the actual zinc chloride according to the standard method made; the holes made in taking these borings to be plugged tightly and completely with creosoted plugs.

ZINC TANNIN TREATMENT.

This vacuum shall be maintained for at least one-half hour, at the expiration of which time zinc chloride shall be admitted without otherwise breaking the vacuum; a pressure of 100 lbs. per sq. in. applied, and maintained until the desired absorption is obtained. The amount of solution injected shall be equivalent to ½-lb. of dry soluble zinc chloride per cubic foot of timber. The solution shall be as weak as can be used, and still obtain the desired absorption of zinc chloride, and shall not be stronger than 5 per cent. The solution shall be treated to a temperature of not less than 140 degrees before admission to the cylinder. If the cylinders are provided with steam coils, steam shall be maintained in these coils during the entire treatment.

After the required amount of zinc chloride has been injected, this solution shall be run off and the ties allowed to drain for 15 minutes. The chloride draining off shall be blown or run off, and a 2 per cent. solution of tannic acid, made by mixing 6⅔ lbs. of 30 per cent. extract of tannin with 100 lbs. of water, run in, and a pressure of 100 lbs. produced and maintained one-half hour. This shall then be run off, a 1 per cent. solution of glue (made by dissolving $2\frac{1}{10}$ lbs. of glue containing 50 per cent. gelatine in 100 lbs. water) shall be admitted to the cylinder and a pressure of 100 lbs. produced and maintained for one-half hour. Care shall be taken to maintain the solution containing the glue and tannic acid up to their original strength in these elements.

The zinc chloride used shall be as free from all impurities of any kind as is practicable, being slightly basic, absolutely free from free acid, containing not more than $\frac{25}{1000}$ of 1 per cent. iron. The amount of chloride specified to be injected shall be of soluble zinc chloride only. The amount of solution absorbed shall be determined by calculation

based on the gage readings of the tanks holding the supply of solution. The strength of the zinc-chloride solution shall be carefully controlled from time to time by hydrometer readings. Borings shall be taken from time to time from at least six ties treated in the same run, and a determination of the actual zinc chloride according to the standard method made; the holes made in taking these borings to be plugged tightly and completely with creosoted plugs.

CREOSOTING.

This vacuum shall be maintained for at least one-half hour, at the expiration of which time dead oil of coal tar shall be admitted without otherwise breaking the vacuum; a pressure of 100 lbs. per sq. in. applied, and maintained until the desired absorption is obtained. The amount of dead oil to be injected shall be that provided for in the contract for ties; recommended to be 10 lbs. per cubic foot. The dead oil shall be heated to a temperature of not less than 140 degrees before admission to the cylinder. All cylinders shall be provided with sufficient steam coils to fully maintain this temperature during injection, steam pressure being maintained in these coils also during vacuum. The dead oil shall comply with the standard specifications therefor, as determined by standard methods of analysis. The amount of oil absorbed shall be determined by calculation based upon gage readings taken before the introduction of the oil into the cylinder and after forcing back the oil after treatment.

All oil shall be analyzed when received at the works; the samples being taken in the manner prescribed by the specifications for oil. At least once during each week samples of oil shall be taken from the cylinders during the treatment and analyzed to determine if the water in the oil exceeds the limit in the specifications. If so, a correspondingly greater amount shall be injected. If this amount of water exceeds 10 per cent., steps shall be taken before it is used to remove the water, so as to bring the oil within the limits of the specifications.

WELLHOUSE TREATMENT.

This vacuum shall be maintained for at least one-half hour, at the expiration of which time zinc chloride containing ½ of 1 per cent. of glue shall be admitted without otherwise breaking the vacuum; a pressure of 100 lbs. per sq. in. applied, and maintained until the desired absorption is obtained. The amount of solution injected shall be equiv-

alent to ½-lb. of dry soluble zinc chloride per cubic foot of timber. The solution of zinc chloride shall be as weak as can be used, and still obtain the desired absorption of zinc chloride, and shall not be stronger than 5 per cent. The solution shall be heated to a temperature of not less than 140 degrees before admission to the cylinder. If the cylinders are provided with steam coils, steam pressure shall be maintained in these coils during the entire treatment.

After the required amount of zinc chloride and glue has been injected, this solution shall be run off and ties allowed to drain for 15 minutes. The chloride and glue draining off shall be blown or run off and a ½ of 1 per cent. solution of tannic acid run in, and a pressure of 100 lbs. produced and maintained 1½ hours. Care shall be taken to maintain the solution containing the glue and tannic acid up to their original strength in these elements.

The zinc chloride used shall be as free from any impurities of any kind as is practicable, being slightly basic, absolutely free from free acid, containing no more than $\frac{25}{100}$ of 1 per cent. of iron. The amount of chloride specified to be injected shall be of soluble zinc chloride only. The amount of solution absorbed shall be determined by calculation based on the gage readings of the tanks holding the supply of solution. The strength of the zinc-chloride solution shall be carefully controlled from time to time by hydrometer readings. Borings shall be taken from time to time from at least six ties treated in the same run, and a determination of the actual zinc chloride according to the standard method made; the holes made in taking these borings to be plugged tightly and completely with creosoted plugs.

TWO-INJECTION ZINC CREOSOTE.

This vacuum shall be maintained for at least one-half hour, at the expiration of which time zinc chloride shall be admitted without otherwise breaking the vacuum; pressure applied, and maintained until the desired absorption is obtained. The amount of solution injected shall be equivalent to $\frac{3}{10}$-lb. of dry soluble zinc chloride per cubic foot of timber. The solution shall be as weak as can be used, and still obtain the desired absorption of zinc chloride, and shall not be stronger than 5 per cent. The solution shall be heated to a temperature of not less than 140 degrees before admission to the cylinder.

The solution of zinc chloride shall then be run out, and dead oil of coal tar immediately admitted to the cylinder, pressure applied of

100 lbs. per sq. in., and oil injected into the ties to the average amount of 3 lbs. of oil per cubic foot of timber. The oil shall be heated to a temperature of not less than 140 degrees before admission to the cylinder. All cylinders must be provided with sufficient steam coils to fully maintain this temperature during injection, and steam shall be maintained in the coils also during injection of the zinc chloride and during vacuum. The dead oil shall comply with the standard specifications therefor, as determined by standard methods of analysis. The amount of oil absorbed shall be determined by calculation based upon gage readings taken before the introduction of the oil into the cylinder, and after forcing back the oil after treatment.

All oil shall be analyzed when received at the works; the samples being taken in the manner prescribed by the specifications for oil. At least once during each week samples of oil shall be taken from the cylinders during treatment and analyzed to determine if the water in the oil exceeds the limit in the specifications. If so, a correspondingly greater amount shall be injected. If this amount of water exceeds 10 per cent., steps shall be taken before it is used to remove the water, so as to bring the oil within the limits of the specifications.

COMMITTEE NO. IV.

RAIL.

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*MINIMUM STANDARD LENGTH OF RAIL.

RECOMMENDED PRACTICE.

The minimum standard length of rail should be 33 ft.

†TEMPERATURE EXPANSION FOR LAYING RAILS.

RECOMMENDED PRACTICE.

The table shows the proper allowance that should be made for expansion for 33-ft. rails.

The temperature should be taken on the rail, and the openings between the rails should be as follows:

TEMPERATURE. (Fahrenheit.)	AMOUNT OF OPENING.
—20° to 0°	5/16 in.
0° to 25°	1/4 in.
25° to 50°	3/16 in.
50° to 75°	1/8 in.
75° to 100°	1/16 in.

Over 100 degrees to be laid close without bumping.

‡SPECIFICATIONS FOR BESSEMER STEEL RAILS.

RECOMMENDED STANDARD SPECIFICATIONS.

Process of Manufacture.

1. (a) The entire process of manufacture and testing shall be in accordance with the best current practice, and special care shall be taken to conform to the following instructions:

(b) Ingots shall be kept in a vertical position in the pit heating

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* Adopted, Vol. 2, 1901, pp. 190, 204-212.
† Adopted, Vol. 2, 1901, pp. 190, 212.
‡ Adopted, Vol. 3, 1902, pp. 204-206, 208-220; Vol. 5, 1904, pp. 465-468, 469-480; Vol. 6, 1905, p. 190; Vol. 7, 1906, pp. 549, 552-555, 559, 560, 562, 573, 576.

furnaces until ready to be rolled, or until the metal in the interior has time to solidify.

(c) No bled ingots shall be used.

(d) There shall be sheared from the end of the blooms formed from the top of the ingots not less than twenty-five (25) per cent., and if, from any cause, the steel does not then appear to be solid, the shearing shall continue until it does. If, by the use of any improvements in the process of making ingots, the defect known as piping shall be prevented, the above shearing requirements may be modified.

Chemical Composition.

2. Rails of the various weights per yard specified below shall conform to the following limits in chemical composition:

	Percentage		
	70 to 79 lbs.	80 to 89 lbs.	90 to 100 lbs.
*Carbon	0.50-0.60	0.53-0.63	0.55-0.65
Phosphorus shall not exceed	0.085	0.085	0.085
Silicon shall not exceed	0.20	0.20	0.20
Sulphur shall not exceed	0.075	0.075	0.075
Manganese	0.75-1.00	0.80-1.05	0.80-1.05

*Carbon may be reduced to suit local conditions.

Drop Test.

3. One drop test shall be made on a piece of rail not less than 4 ft. and not more than 6 ft. long, selected from each blow of steel. The test piece shall be taken from the top of the ingot. The rails shall be placed head upward on the supports, and the various sections shall be subjected to the following impact tests under a free falling weight:

70 to 79-lb. rails.....18 ft.
80 to 89-lb. rails.....20 ft.
90 to 100-lb. rails.....22 ft.

If any rail breaks when subjected to the drop test, two additional tests may be made of other rails from the same blow of steel, also taken from the top of the ingot, and if either of these latter rails fail, all the rails of the blow which they represent will be rejected, but if both of these additional test pieces meet the requirements all the rails of the blow which they represent shall be accepted.

Drop Testing Machine.

4. The drop-testing machine shall have a tup of 2,000 lbs. weight, the striking face of which shall have a radius of not more than 5 in., and the test rail shall be placed head upward on solid supports 3 ft. apart. The anvil block shall weigh at least 20,000 lbs., and the supports shall be part of, or firmly secured to, the anvil. The report of the drop test shall state the atmospheric temperature at the time the test was made.

Shrinkage Allowance (for Rails 33 ft. long).

5. The number of passes and speed of train shall be so regulated that on leaving the rolls at the final pass, the temperature of the rail will not exceed that which requires a shrinkage allowance at the hot saws for a 33-ft. rail of 100-lb. section of 6 7/16 in., and 1/16-in. less for each 5-lb. decrease of section, these allowances to be decreased at the rate of 1/80-in. for each second of time elapsed between the rail leaving the finishing rolls and being sawn. No artificial means of cooling the steel shall be used after the rails leave the rolls, nor shall they be held before sawing for the purpose of reducing their temperature.

Chemical Analyses.

6. The manufacturer shall furnish the inspector, daily, with carbon determinations for each blow, and a complete chemical analysis every twenty-four hours, representing the average of the other elements contained in the steel, for each day and night turn. These analyses shall be made on drillings taken from small test ingots.

Section.

7. Unless otherwise specified, the section of rail shall be the American Standard, recommended by the American Society of Civil Engineers, and shall conform, as accurately as possible, to the templet furnished by the railroad company, consistent with paragraph No. 8, relative to specified weight. A variation in height of one-sixty-fourth (1/64) inch less, or one-thirty-second (1/32) inch greater than the specified height and one-sixteenth (1/16) inch in width, shall be permitted. The section of rail shall conform perfectly to the fishing dimension.

Weight.

8. The weight of the rails will be maintained as nearly as possible, after complying with paragraph No. 7, to that specified in contract. A variation of one-half (1/2) of one per cent. for an entire order will be allowed. Rails shall be accepted and paid for according to actual weights.

Length.

9. The standard length of rails shall be thirty-three (33) ft. Ten per cent. of the entire order will be accepted in shorter lengths, varying by even feet to twenty-seven (27) ft., and all No. 1 rails less than 33 ft. shall be painted green on the end. A variation of one-fourth of an inch in length from that specified will be allowed.

Drilling.

10. Circular holes for splice bars shall be drilled in accordance with the specifications of the purchaser. The holes shall accurately conform to the drawings and dimensions furnished in every respect, and shall be free from burrs.

Finish.

11. Rails shall be straight in line and surface when finished, the straightening being done while cold, smooth on head, sawed square at ends, variation to be not more than 1/32-in., and, prior to shipment, shall have the burr occasioned by the saw cutting removed and the ends made

clean. No. 1 rails shall be free from injurious defects and flaws of all kinds.

Straightening.

12. Care shall be taken in hot straightening the rails, resulting in their being left in such a condition that they shall not vary throughout their entire length of 33 ft. more than 3 in. from a straight line in any direction, when delivered to the cold straightening presses. Those which vary beyond that amount, or have short kinks, shall be classed as second quality rails, and be so stamped. The distance between supports of rails in the gagging press shall not be less than 42 in.

Branding.

13. The name of the maker, the weight of rail and the month and year of manufacture shall be rolled in raised letters on the side of the web, and the number of blow shall be plainly stamped on each rail where it will not subsequently be covered by the splice bars.

Inspection.

14. The inspector representing the purchaser shall have free entry to the works of the manufacturer at all times when the contract is being filled, and shall have all reasonable facilities afforded him by the manufacturer to satisfy him that the finished material is furnished in accordance with the terms of these specifications. All tests and inspection shall be made at the place of manufacture prior to shipment.

No. 2 Rails.

15. No. 2 rails will be accepted up to five (5) per cent. of the whole order. Rails possessing any injurious defects, or which for any other cause are not suitable for first quality, or No. 1 rails, shall be considered as No. 2 rails; provided, however, that rails which contain any physical defects which impair their strength shall be rejected. The ends of all No. 2 rails shall be painted white in order to distinguish them. Rails rejected under the drop test will not be accepted as No. 2 rails.

COMMITTEE NO. V.

TRACK.

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*TRACK.

DEFINITIONS.

TRACK.—Ties, rails and fastenings with all parts in their proper relative places.

ALINEMENT.—The horizontal location of a railroad with reference to curves and tangents.

LINE.—The condition of the track in regard to uniformity in direction over short distances on tangents, or uniformity in variation in direction over short distances on curves.

TANGENT.—Straight track.

CURVE.—A change in direction by means of one or more radii.

CURVE, SIMPLE.—A change in direction by means of a single radius.

CURVE, COMPOUND.—A change consisting of two or more simple curves of different radii, all in the same direction, joining one another at points with common tangent.

CURVE, REVERSE.—Two curves in opposite directions in a continuous line joining at a common tangent point.

CURVE, EASEMENT.—A curve of regular varying radii connecting a tangent to a simple curve, or connecting two simple curves.

CURVE, VERTICAL.—A curve used to connect intersecting grade lines.

SURFACE.—The condition of the track as to vertical evenness or smoothness over short distances.

LEVEL.—The condition of the track in which the elevation of the rails transversely is equal.

ELEVATION (as applied to curves).—The amount which the outer rail is raised above the inner rail.

GAGE, STANDARD.—The gage of 4 ft. 8½ in.

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* Adopted, Vol. 5, 1904, pp. 527, 535, 541-560; Vol. 6, 1905, pp. 748, 749, 759-761.

GAGE (OF TRACK).—The distance between the heads of the rails measured at right angles thereto at a point 5/8-in. below the top of the rail.

FASTENINGS.—Splices, bolts and spikes.

AUXILIARY FASTENINGS.—Nutlocks, tie-plates, rail braces, and anti-creeping devices.

*MAINTENANCE OF LINE AND ALINEMENT.

RECOMMENDED PRACTICE.

(a) Adjustment of Tangents:

Tangents should be adjusted by throwing the tangent between summits; between curves; or by throwing curves to meet tangents; or by partially throwing curves and partially throwing tangents, as may require the least work. Centers should be set with transit to insure accurate line.

(b) Adjustment of Curves, with consideration as to Easement Curves:

Easement curves should be used as follows:

For speed not exceeding 30 miles per hour, on all curves exceeding 2 degrees.

For speed not exceeding 60 miles per hour, on all curves exceeding 1 degree.

Where higher speed is attained, on all curves exceeding 30 minutes.

Easement curves should be used between curves of different degrees in the same way that they are used between curves and tangents.

The length of easement curves should be the same as the distance in which the curve elevation is run out; therefore, as the elevation of curves depends not alone on the degree, but also on the speed of trains, the length of the easement curve should vary in the same manner.

For ordinary practice, a chord length equivalent to 100 ft. for each degree of variation in curvature is recommended.

Where the distance between curves will not allow this, or for other reasons, a chord length of 25 to 30 ft. may be used.

For very high-speed roads, a chord length equivalent to 150 ft. or more per degree of variation is recommended.

Any form of transition curve is satisfactory which gradually changes the degree of curvature, and in which the length of chord per degree of variation can readily be changed to suit each particular case, the essential point being that the length of the easement curve shall be the same as

*Adopted, Vol. 3, 1902, pp. 55, 56, 67-78; Vol. 5, 1904, pp. 527, 528, 535, 561, 562; Vol. 6, 1905, pp. 753, 754, 759-761.

the distance in which the elevation of the outer rail is raised from zero to full elevation.

Any transition curve of the type of the Searles, Crandall, Holbrook, Talbot or cubic parabola, which shall be susceptible of being run in by deflection or offset, is recommended.

(c) Method of Securing and Maintaining Perfect Line:

Permanent witnesses should be placed at points of tangent, points of spiral, points of change of curvature, summits, and at such other points along curves or tangents as will enable the alinement to be identically reproduced with a transit.

*MAINTENANCE OF SURFACE.

RECOMMENDED PRACTICE.

(a) Elevation of Curves, with special consideration as to amount and beginning and end of elevation, and as modified by location of curve and conditions of traffic.

The approximate formula,

$$e = \frac{Gv^2}{32.16\,R}$$

in which
e = Elevation in feet,
G = Gage of track in feet,
v = Velocity in feet per second,
R = Radius of curve in feet,

will give essentially correct theoretical elevation for the outer rail of curves, and is recommended for ordinary practice, but must be modified as noted below to suit special conditions.

For greater convenience the formula above may be further reduced by substituting

$$v = \frac{V5280}{3600},$$

$$G = 4.708,$$

$$R = \frac{5730}{D}\ (\text{approx.}),$$

$$e = 1\text{-}12\ E,$$

in which V = Velocity in miles per hour,
D = Degree of curve,
and E = Elevation of outer rail in inches;
whence $E = .00066\ DV^2$.

This formula will give results which are expressed in the accompanying table:

* Adopted, Vol. 3, 1902, pp. 56-59, 78-87; Vol. 5, 1904, pp. 528-533, 535, 562, 563; Vol. 6, 1905, pp. 754-757, 759-761.

ELEVATION OF OUTER RAIL IN INCHES

Degree of Curve.	Velocity in Miles per Hour.													Degree of Curve.
	10	15	20	25	30	35	40	45	50	55	60	65	70	
1	0	⅛	¼	⅜	⅝	¾	1⅛	1⅜	1⅝	2	2⅜	2¾	3¼	1
2	⅛	⅜	½	⅞	1⅛	1⅝	2⅛	2⅝	3¼	4	4¾	5½	6½	2
3	¼	⅛	¾	1¼	1¾	2⅜	3⅛	4	4⅞	6	7⅛	8⅜	9¾	3
4	¼	⅝	1	1⅝	2⅜	3¼	4¼	5⅜	6⅝	8	9½	.....	.....	4
5	⅜	¾	1¼	2	3	4	5¼	6⅝	8¼	.....	.....	.....	.....	5
6	⅜	1	1⅝	2½	3½	4⅞	6¼	8	.....	.....	.....	.....	.....	6
7	½	1⅛	1⅞	2⅞	4⅛	5⅝	7⅜	.....	.....	.....	.....	.....	.....	7
8	½	1¼	2⅛	3¼	4¾	6½	8⅜	.....	.....	.....	.....	.....	.....	8
9	⅝	1⅜	2⅜	3¾	5⅜	7¼	.....	.....	.....	.....	.....	.....	.....	9
10	¾	1½	2⅝	4⅛	5⅞	8⅛	.....	.....	.....	.....	.....	....	.....	10
11	¾	1¾	2⅞	4½	6¼	8⅞	.....	.....	.....	.....	.....	.....	.....	11
12	⅞	1⅞	3⅛	4⅞	7⅛	.....	.....	.....	.....	.....	.....	.....	.....	12
13	⅞	2	3⅜	5⅜	7¾	.....	.....	....	.....	.....	.....	.....	.....	13
14	1	2⅛	3⅝	5¾	8⅜	.....	.....	.....	.....	.....	.....	.....	.....	14
15	1	2¼	3⅞	6⅛	8⅞	.....	.....	.....	.....	.....	.....	.....	.....	15
16	1⅛	2⅜	4¼	6⅝	.....	.....	.....	.....	.....	.....	.....	.....	.....	16
17	1¼	2⅝	4⅛	7	.....	.....	.....	.....	.....	.....	.....	.....	.....	17
18	1¼	2¾	4¾	7⅛	.....	.....	.....	.....	.....	.....	.....	.....	.....	18
19	1⅜	2⅞	5	7¾	.....	.....	.....	.....	.....	.....	.....	.....	.....	19
20	1⅜	3	5¼	8⅛	.....	.....	.....	.....	.....	.....	.....	.....	.....	20

Since the elevation required is a function of, and depends upon, the train speed, this speed is the first element to be determined.

In general, as a matter of safety, the preference should be given to fast passenger traffic.

Ordinarily an elevation of 8 in. should not be exceeded and speed of trains should be regulated to conform to that elevation.

The elevation of curves should be zero at the point of spiral and should increase to full elevation at the end of the spiral or beginning of the simple curve.

In ordinary practice, it is recommended that the elevation be run out at the rate of 1 in. in 60 ft., but this will be modified by the same conditions that should vary the length of the easement curve used.

The inner rail should be maintained at grade.

(b) Vertical Curves:

The use of vertical curves to connect changes in gradient are so obvious as to require no argument.

The length should be determined by the gradients to be connected. On first-class lines a rate of change of 0.1 per station on summits and 0.05 per station in sags should not be exceeded. On minor lines 0.2 per station on summits and 0.1 per station in sags may be used.

(c) Proper Methods of Tamping.

(1) Earth or Clay Ballast.

Tools: Shovel equipped with iron cuff or handle for tamping; broad pointed tamping bars.

Work: Tamp each tie from 18 in. inside of the rail to end of tie with handle of shovel or tamping bar. If possible, tamp the end of the tie outside of rail first and let train pass over before tamping inside of rail; give special attention to tamping under the rail; tamp center of ties loosely with the blade of the shovel; the dirt or clay between the ties should be placed in layers and firmly packed with feet or otherwise, so that it will quickly shed the water; the earth should not be banked above the bottom of the ends of the ties; the filling between the ties should not touch the rail and should be as high as, or higher than, the top of the ties in the middle of the track.

(2) Cinder Ballast (Railroad Product):

Tools: Shovel, tamping bar or tamping pick.

Work: Same as for gravel.

(3) Burnt Clay Ballast:

Tools: Shovel only in soft material. When burnt very hard, tamping pick or bar should be used.

Work: Tamp 15 in. inside of rail to end of tie, tamping end of tie first, letting train pass before tamping inside of rail; tamp center loosely; tamp well between the ties; dress ballast same as for earth or cinders.

(4) Broken Stone or Furnace Slag:

Tools: Shovel, tamping pick, stone forks.

Work: Tamp 15 in. inside of rail to end of tie; if possible, tamp the end of the tie outside of rail first and allow train to pass over before tamping inside of rail; tamp well under the rail; tamp well under ties from end of same; do not tamp center of tie; fill in between ties to height of top of tie; bank ballast into shoulder about the end of the ties level with top of tie.

(5) Chat, Gravel or Chert Ballast:

Tools: Shovel, tamping pick or tamping bar. For light traffic, shovel tamping is sufficient. For heavy traffic, the tamping pick or tamping bar should be used. The tamping bar is recommended instead of the tamping pick for ordinary practice.

Work: Tamp solid from a point 15 in. inside of rail to the end of the tie; if possible, tamp the end of the tie outside of the rail first and allow train to pass over before tamping inside of rail; care should be taken not to disturb the old bed. Tie should be tamped solidly from the end, using pick or tamping bar. After train has passed, the center of the tie should be loosely tamped with the blade of the shovel. Dress same as stone ballast.

(6) General:

When not surfacing out of face, as in case of picking up low joints or other low places, the general level of the track should not be disturbed. Where the rails are out of level, but where the difference in elevation is not excessive and is uniform over long stretches of track, a difference in elevation between the two rails of 3/8-in. may be allowed to continue until such time as the track would ordinarily be surfaced out of face.

*MAINTENANCE OF GAGE.

RECOMMENDED PRACTICE.

(a) Methods used to prevent spreading of track and canting of rails on curves.

(1) For heavy traffic, tie-plates should be used on all ties on curves.

(2) For medium traffic, all curves over 3 degrees should be tie-plated.

(3) For light traffic, the outside of rails should be double-spiked.

(4) Tie-plates are recommended in preference to rail braces, except for guard rails and stock rails at switches, where the latter should be used.

(5) Tie-plates should be applied in all cases where greater economy in maintenance is secured by their use than in depending on the life of the tie limited by rail wear.

(b) Proper Method of Spiking:

(1) The gage (tool) used should be the standard gage recommended.

(2) When track is intended to be spiked to standard gage the rail should be held against the gage with a bar while the spike is being driven.

(3) Within proper limits a slight variation of the gage from standard is not seriously objectionable, provided the variation is uniform and constant over long distances. Under ordinary conditions it is not necessary to regage track if the increase in gage has not amounted to more than three-eighths of an inch, provided such increase is uniform.

(4) All spikes should be started vertically and square, and so driven that face of spike should come in contact with base of rail; the spike should never have to be straightened while being driven.

(5) The outside spikes of both rails should be on the same side of the tie, and the inside spikes on the opposite side of the tie. The inside

* Adopted, Vol. 5, 1904, pp. 534, 535, 563-569; Vol. 6, 1905, pp. 749, 750, 757, 759-761; Vol. 7, 1906, pp. 654, 664.

and outside spikes should be separated as far apart as the face and character of the tie will permit. The ordinary practice should be to drive the spike 2½ in. from the outer edge of the tie. All old spike holes should be plugged.

*STANDARD DRILLING FOR RAILS.

RECOMMENDED PRACTICE.

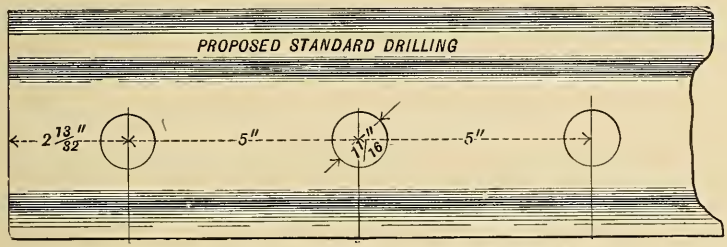
JOINT RECOMMENDATION OF TRACK AND RAIL COMMITTEES.

The standard drilling for rails should be as follows:

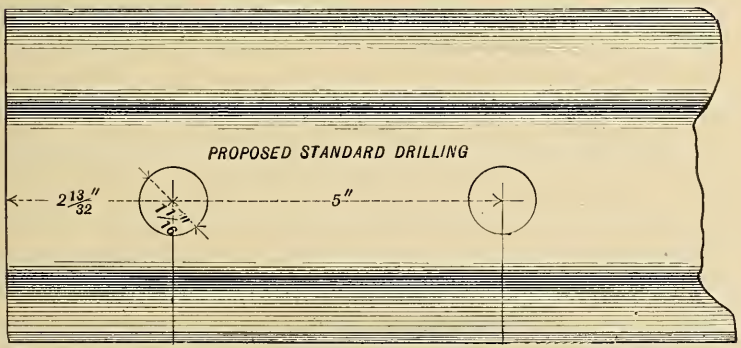
End of rail to center first hole..... $2\frac{13}{32}$ in.
Center of first hole to center second hole..... 5 in.
Center second hole to center third hole..... 5 in.

Diameter of hole in rail should be $\frac{3}{16}$-in. larger than diameter of bolt used.

The punching in splices should be alternately oblong and round, to permit staggering bolts in rail, high enough to allow it without flange interference; the round hole (diameter) to be $\frac{1}{16}$-in. larger than the diameter of bolts over thread.



STANDARD DRILLING FOR SIX-HOLE SPLICE.



STANDARD DRILLING FOR FOUR-HOLE SPLICE.

* Adopted, Vol. 5, 1904, pp. 518, 520, 525, 569-571; Vol. 6, 1905, pp. 757, 759-761.

*STANDARD RAIL JOINT.

GENERAL REQUIREMENTS.

A standard rail joint should fulfill the following general requirements:

(1) It should connect the rails into a uniform continuous girder.

(2) It should be strong enough to resist deformation or taking permanent set.

(3) It should prevent deflection or vertical movement of the ends of the rails and permit movement lengthwise for expansion.

(4) It should be as simple and of as few parts as possible to be effective.

(5) Finally, its cost must not be prohibitive.

†FROG BLOCKING.

RECOMMENDED PRACTICE.

The heel of all frogs should be made with a steel filler block, to fit the section of rail, securely bolted in, and with the outer end of filler planed off ⅜-in. below top of rail to act as a riser for the outer edge of worn treads.

The wings and throat of all frogs should be blocked with a metal or wood blocking, shaped to fit rail sections, to give 1½-in. flange clearance, and be securely bolted to frog.

‡INSPECTION OF TRACK.

RECOMMENDED PRACTICE.

(1) Except in case of roads of very light traffic, all main track should be inspected each day by section gang or trackwalker.

(2) Trackwalker or patrol should be sent out in case of storm, etc., and during the period when slides or falling stone, etc., are to be expected.

(3) The trackwalker should be provided with spike maul, spikes and proper signals.

(4) His duties should be to carefully inspect the track, roadway, fences, gates, bridges, culverts and telegraph line, and in general guard against all damage or danger to any railroad property.

(5) In case of trouble he should place torpedoes and other danger signals a sufficient distance to protect trains, and should notify the proper officers from the nearest possible point.

(6) Supervisors or Roadmasters should be required to go over the whole of their districts on foot or on handcar at least once every month, making close inspection of all details.

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* Adopted, Vol. 7, 1906, pp. 655, 657.

† Adopted, Vol. 5, 1904, pp. 525, 526, 571; Vol. 6, 1905, pp. 757, 758, 75 51.

‡ Adopted, Vol. 7, 1906, pp. 654, 656, 664.

COMMITTEE NO. VI.

BUILDINGS.

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*CONCLUSIONS RELATIVE TO ONE GENERAL WAITING ROOM OR SEPARATE WAITING ROOMS IN A LOCAL PASSENGER STATION (WITHOUT REFERENCE TO SEPARATE WAITING ROOMS FOR COLORED PEOPLE).

RECOMMENDED PRINCIPLES OF PRACTICE.

The use of one general waiting room for a local passenger station (without reference to separate waiting rooms for colored people) is recommended as good practice for the following reasons:

(1) It allows the general waiting room to be properly proportioned.

(2) It permits proper development of a retiring room for women with private entrance to their toilet.

(3) It readily admits of the other rooms being properly proportioned.

(4) It allows ease of access from agent's office to the trains, to the baggage room and to the waiting room.

(5) It allows the ticket office to be used for a registering or an "O. S"ing office.

(6) It admits of the station being contracted in size without detriment of facilities.

(7) It offers economy in heating.

(8) It admits easily of varied treatment architecturally.

†REQUIREMENTS OF A MODERN ROUNDHOUSE.

RECOMMENDED PRACTICE.

It is recommended that a modern roundhouse be designed and equipped as follows:

(1) In a circular house the locomotives should stand in the house normally with the tender toward the turntable.

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* Adopted, Vol. 6, 1905, pp. 682-684, 690.

† Adopted, Vol. 6, 1905, pp. 684-686, 690-696.

(2) The distance from center of turntable to the inner side of roundhouse should be determined by the number of stalls required in the full circle.

The length of stall along center line of track should be not less than 85 ft. in clear.

(3) The clear opening of entrance doors should be not less than 12 ft. in width and 17 ft. in height.

(3) The clear opening of entrance doors should be not less than of 180°, so that the tracks at the opposite ends of the turntable will "line up" with it.

(4) The turntable should be not less than 75 ft. in length.

The table should be operated by power, preferably electric.

(5) The material used in construction of the house should be non-corrosive, unless proper care be taken to prevent corrosion.

(6) Engine pits should be not less than 60 ft. in length, with convex floor, and with drainage toward the turntable. The walls and floors may be of concrete, and proper provision should be made in construction for the support of the jacking timbers.

(7) Roundhouse doors should be made of non-corrosive material.

(8) Smoke jacks should be fixed, having large hoods; constructed preferably of non-corrosive material and supplied with dampers. The cross-section of the stack should be not less than 30 in. in diameter.

(9) The floor should be of permanent construction. It should be crowned between pits, and that part adjacent to pits within jacking limits should be of wood.

(10) Drop pits should be furnished for handling truck wheels, driving wheels and tender wheels. These can be most economically constructed in pairs.

(11) If the building is heated with hot air, it should be by the indirect method, and the supply should be taken from the exterior of the building (no recirculation of air should be allowed). The air should be delivered to the pits under the engine portion of the locomotive.

Air ducts should be located under the floor and special precaution should be taken to keep them dry.

(12) As much light should be obtained from the exterior of the building as good construction will allow.

(13) There should be an arc light, and a plug outlet for incandescent lights in each space between stalls.

(14) The contents of boilers should be taken care of and discharged outside of the building in a suitable receptacle and the heat units used as may be deemed best.

(15) Cold water should be supplied at each alternate space between stalls from an outlet not less than 2½ in., located at a point about opposite front end of firebox; the water pressure should be not less than 80 lbs. The hydrants should be located below the floor in properly constructed pits amply drained.

Modern practice requires the use of hot water in the maintenance of boilers.

(16) Compressed air is used for mechanical hoisting and blowing operations. Overhead outlets should be furnished in each space between stalls opposite front end of fire box. The pressure should be from 80 to 100 lbs.

(17) A roundhouse should have facilities for the location of a few necessary machine tools, preferably electrically driven.

(18) Air hoists, or portable gooseneck cranes with differential blocks, on wheels, should be furnished for handling heavy repair parts.

(19) The turntable pit side walls should be of concrete with wooden coping not less than 6 in. thick, and the ties under the circular rail should be supported on concrete walls. Pivot masonry may be of concrete with stone cap.

*ROUNDHOUSE DOORS.

RECOMMENDED PRINCIPLES OF PRACTICE.

Roundhouse doors should be made of non-corrosive material; they should be easily operated, fit snugly, be easily repaired and maintained, and should not be exposed to damage by wind, directly or indirectly, and should admit of the use of small doors.

The particular kind of door that will suit a given case can be determined only by giving the proper value to the different factors enumerated above.

†ENGINE HOUSES

RECOMMENDED PRINCIPLES OF PRACTICE.

The circular form of an engine house is, in general, recommended as the preferable design, with possibly the following exceptions:

(a) At branch terminals, or similar points, where not more than three or four locomotives are housed at one time and where it is more economical to provide a "Y" track than a turntable, or where it is not

* Adopted, Vol. 7, 1906, pp. 631, 639.
† Adopted, Vol. 7, 1906, pp. 628, 629, 635.

necessary to turn the locomotives, a through rectangular house, or with switches at one end only, may be desirable.

(b) At shops where a transfer table is used and an engine house is to be added, and at special locations, a transfer table house may be desirable.

*SMOKE JACKS.

RECOMMENDED PRINCIPLES OF PRACTICE.

The engine house smoke jack should be fixed; the bottom opening should be not less than forty-two (42) in. wide, and long enough to receive the smoke from the stack at its limiting positions, due to the adjustment of the driving wheels to bring the side rods in proper position for repairs. The bottom of the jack should be as low as the engines served will allow, and it should be furnished with a drip trough; the slope upward should be gradual to the flue; the size of the flue for the largest locomotives should be not less than forty-two (42) in. in diameter; a damper should be provided in the flue, easily adjusted from the floor, and the material used should be non-combustible and non-corrosive.

†LOCOMOTIVE COALING STATIONS.

RECOMMENDED PRINCIPLES OF PRACTICE.

(1) The cost items should include charges for interest and depreciation, charges for maintenance and operation (the cost of switching cars onto trestles should be included), and a charge for the use of cars for storage purposes.

(2) Provision should be made for fire protection, the avoidance of damage to the coal, and its delivery in the best possible condition.

(3) The use of self-clearing cars should be made possible, and ordinarily it should also be possible to shovel from flat-bottomed cars.

(4) Storage for emergency purposes and fireproof construction are, in general, to be recommended, and in some cases duplicate machinery is desirable.

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* Adopted, Vol. 7, 1906, pp. 630, 638.
† Adopted, Vol. 8, 1907, pp. 268, 286.

COMMITTEE NO. VII.

WOODEN BRIDGES AND TRESTLES.

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*WOODEN BRIDGES AND TRESTLES.

DEFINITIONS.

Wooden Trestle.—A wooden structure composed of upright members supporting simple horizontal members or beams, the whole forming a support for loads applied to the horizontal members.

Frame Trestle.—A structure in which the upright members or supports are framed timbers.

Pile Trestle.—A structure in which the upright members or supports are piles.

Bent.—The group of members forming a single vertical support of a trestle, designated as pile bent where the principal members are piles, and as framed bent where of framed timbers.

Post.—The vertical and battered members of the bent of a framed trestle.

Pile.—Timber driven in the ground, and intended generally to support a structure.

Batter.—A deviation from the vertical in upright members of a bent.

Cap.—A horizontal member upon the top of piles or posts, connecting them in the form of a bent.

Sill.—A lower horizontal member of a framed bent.

Sub-Sill.—Timber bedded in the ground to support framed bents.

Intermediate Sill.—A horizontal member in the plane of the bent between the cap and sill to which the posts are framed.

Sway Brace.—A member bolted or spiked to the bent and extending diagonally across its face.

Longitudinal Strut or Girt.—A stiff member running horizontally, or nearly so, from bent to bent.

Longitudinal X Brace.—A member extending diagonally from bent to bent in a vertical or battered plane.

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* Adopted, Vol. 6, 1905, pp. 35, 36, 42, 55-67; Vol. 7, 1906, pp. 683, 684.

Sash Brace.—A horizontal member secured to the posts or piles of a bent.

Stringer.—A longitudinal member extending from bent to bent and supporting the ties.

Jack Stringer.—A single line of stringers placed outside of the main stringers.

Tie.—A transverse timber resting on the stringers and supporting the rails.

Guard Rail.—A longitudinal member, either iron or wood, secured on top of ties.

Packing Block.—A small member, usually wood, used to secure the parts of a composite member in their proper relative positions.

Packing Spool or Separator.—A small casting used in connection with packing bolts to secure the several parts of a composite member in their proper relative positions.

Drift Bolt.—A piece of round or square iron of specified length, with or without head or point, driven as a spike.

Dowel.—An iron or wood pin, extending into, but not through, two members of the structure to connect them.

Shim.—A small piece of wood or metal placed between two members of a structure to bring them to a desired relative position.

Fish-Plate.—A short piece lapping a joint, secured to the side of several members, which are butt-jointed.

Bulkhead.—Timber placed against the side of an end bent for the purpose of retaining the embankment.

*DEFECTS OF STRUCTURAL TIMBER.

RECOMMENDED STANDARD DEFINITIONS.

The standard defects included in the following list are mostly such as may be termed natural defects, as distinguished from defects of manufacture. The latter have usually been omitted, because the defects of manufacture are of very minor significance in the grading of structural timber:

Sound Knot.—A sound knot is one which is solid across its face and is as hard as the wood surrounding it. It may be either red or black, and is so fixed by growth or position that it will retain its place in the piece.

* Adopted, Vol. 8, 1907, pp. 401-408, 450-452.

Loose Knot.—A loose knot is one not firmly held in place by growth or position. (See Fig. 1.)

Pith Knot.—A pith knot is a sound knot with a pith hole not more than ¼-in. in diameter* in the center. (See Fig. 2.)

Encased Knot.—An encased knot is one which is surrounded wholly or in part by bark or pitch. Where the encasement is less than ⅛ of an inch in width on each side, nor exceeding one-half the circumference of the knot, it shall be considered a sound knot. (See Fig. 3.)

Rotten Knot.—A rotten knot is one not as hard as the wood surrounding it. (See Fig. 4.)

Pin Knot.—A pin knot is a sound knot not over ½-in. in diameter. (See Fig. 5.)

Standard Knot.—A standard knot is a sound knot not over 1½ in. in diameter. (See Fig. 6.)

Large Knot.—A large knot is a sound knot, more than 1½ in. in diameter. (See Fig. 7.)

Round Knot.—A round knot is one which is oval or circular in form.

Spike Knot.—A spike knot is one sawn in a lengthwise direction. The mean or average diameter shall be taken as the size of these knots. (See Fig. 8.)

Pitch Pockets.—Pitch pockets are openings between the grain of the wood, containing more or less pitch or bark. These shall be classified as small, standard and large pitch pockets.

Small Pitch Pocket (a).—A small pitch pocket is one not over ⅛ of an inch wide. (See Fig. 9.)

Standard Pitch Pocket (b).—A standard pitch pocket is one not over ⅜ of an inch wide nor over 3 in. in length.

Large Pitch Pocket (c).—A large pitch pocket is one over ⅜ of an inch wide, or over 3 in. in length.

Pitch Streak.—A pitch streak is a well-defined accumulation of pitch at one point in the piece. When not sufficient to develop a well-defined streak, or where the fiber between grains, that is, the coarse grained fiber, usually termed "spring wood," is not saturated with pitch, it shall not be considered a defect. (See Fig. 10.)

Wane.—Wane is bark, or the lack of wood from any cause, on edges of timbers.

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* Measurements which refer to the diameter of knots or holes shall be considered as the mean or average diameter in all cases.

Shakes.—Shakes are splits or checks in timbers which usually cause a separation of the wood between annual rings.

Rot, Dote and Red Heart.—Any form of decay which may be evident either as a dark red discoloration not found in the sound wood, or the presence of white or red rotten spots, shall be considered as a defect.

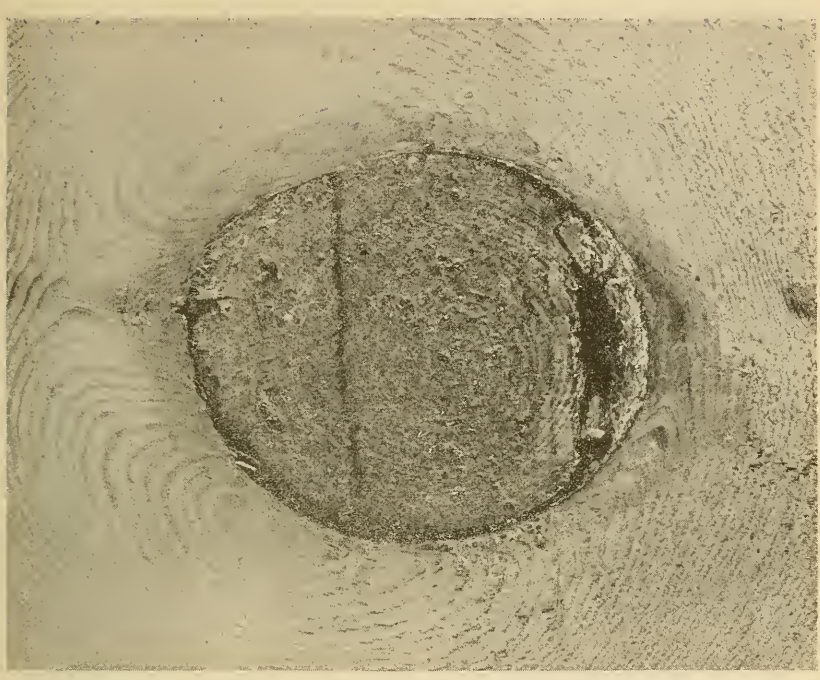


FIG. 1.—LOOSE KNOT.

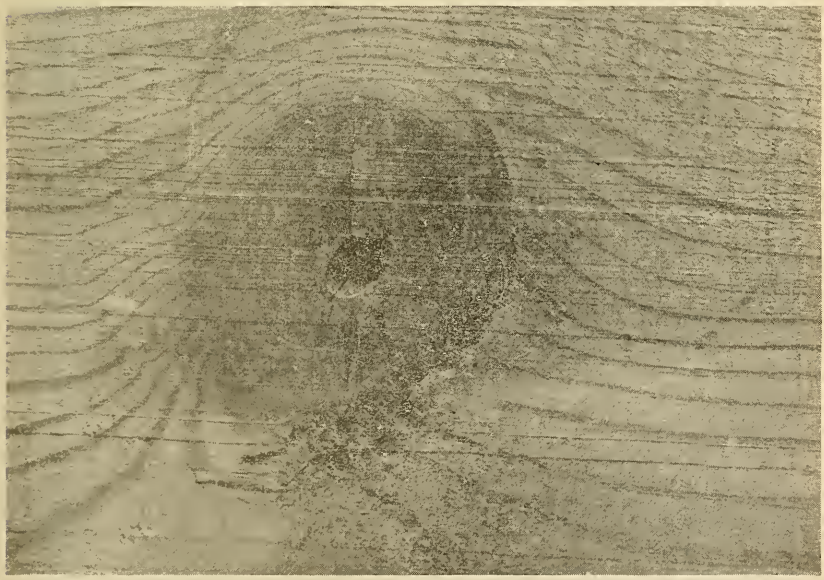


FIG. 2.—PITH KNOT.

FIG. 3.—ENCASED KNOT.

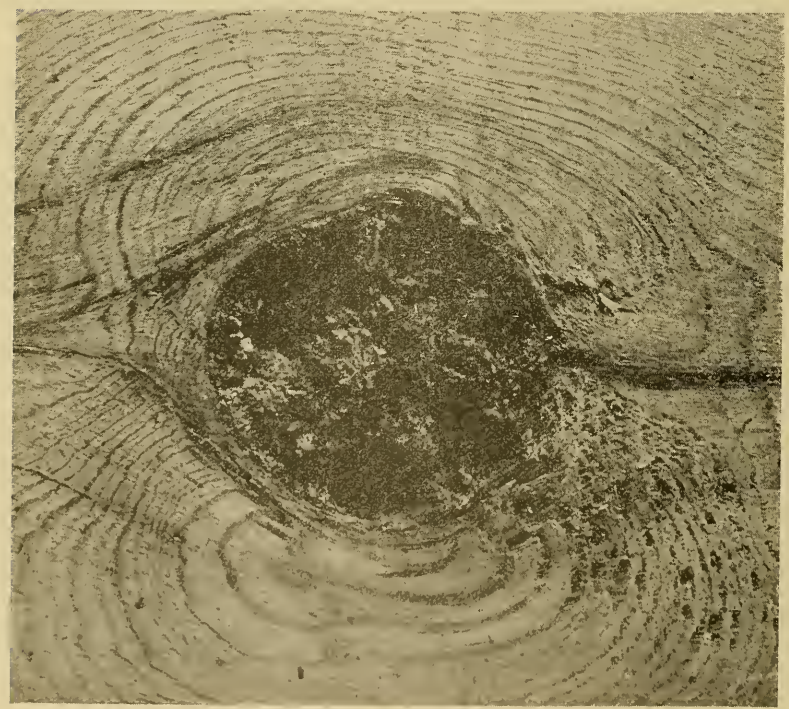


FIG. 4.—ROTTEN KNOT.

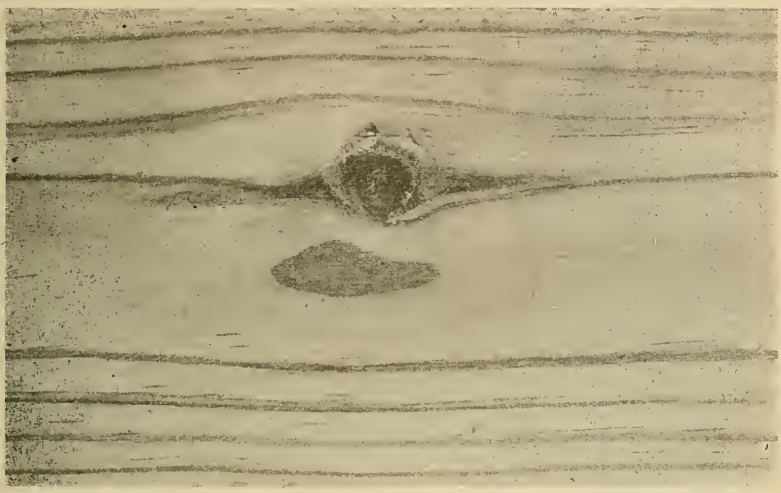


FIG. 5.—PINE KNOT.

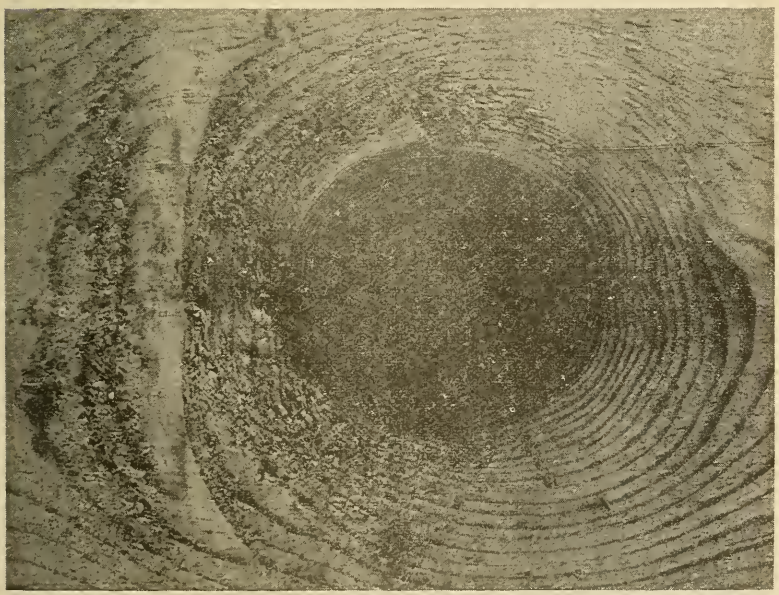


FIG. 6.—STANDARD KNOT.

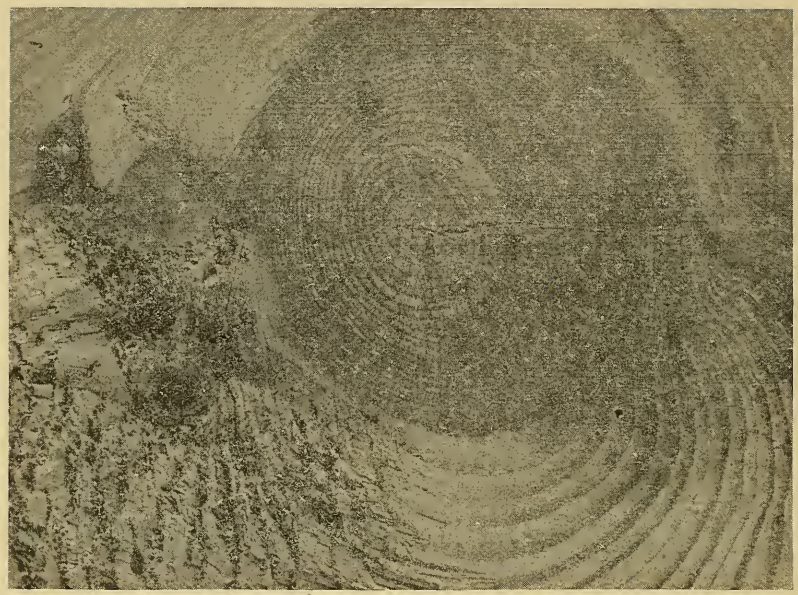


FIG. 7.—LARGE KNOT.

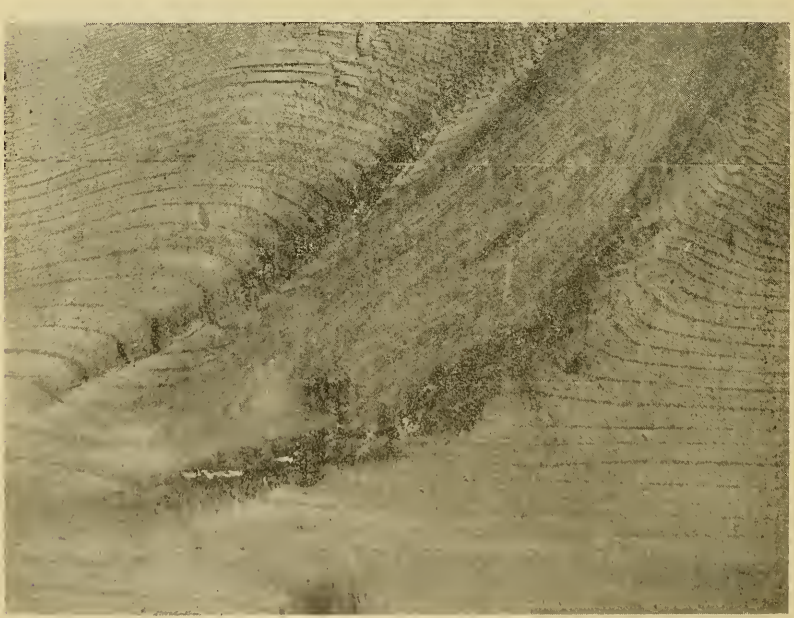


FIG. 8.—SPIKE KNOT.

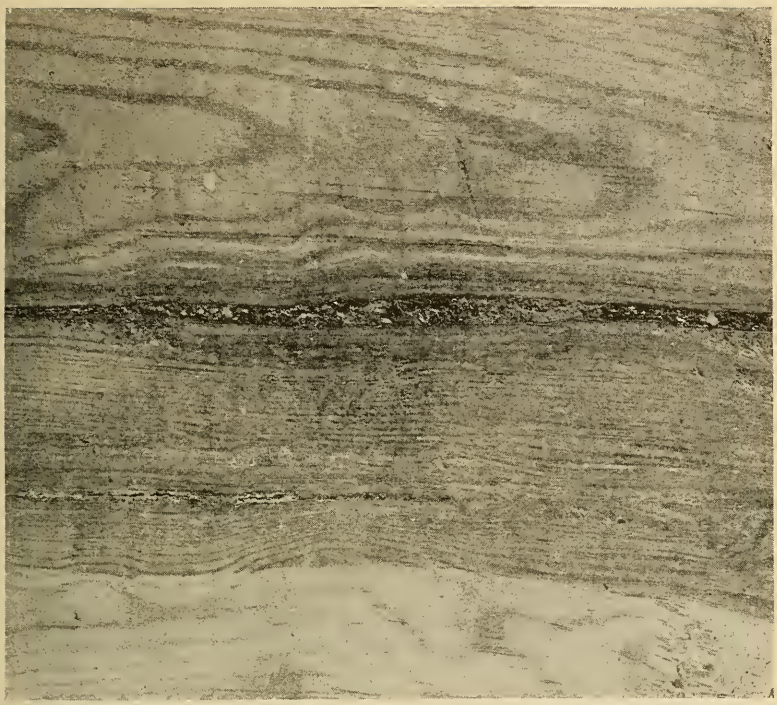


FIG. 9.—SMALL PITCH POCKET.

FIG. 10.—PITCH STREAK.

*SPECIFICATIONS FOR BRIDGE AND TRESTLE TIMBER AND PILING.

RECOMMENDED STANDARD SPECIFICATIONS.

BRIDGE AND TRESTLE TIMBER.

General Requirements.

1. All timber shall be cut from sound trees, grain to show a large proportion of hard summer wood, sawed to full size, rectangular in section and out of wind; it shall be free from ring shakes, unsound knots or sound knots over one and one-half (1½) in. in diameter when not otherwise specified, knots in groups, pitch seams, decay or defects that will impair its strength or durability.

Guard Rail.

2. (a) LONG-LEAF YELLOW PINE.—One face shall show all heart, the other face and both sides shall show not less than 75 per cent. heart, measured across the sides anywhere on the piece.

(b) DOUGLAS FIR.—One face shall show all heart, the other face and both edges shall show not less than 75 per cent. heart, measured across the surface anywhere on the piece. It shall show not less than an average of 12 annual rings to the inch.

Bridge Ties.

3. (a) LONG-LEAF YELLOW PINE, WHITE, POST AND BURR OAK.—Shall not show less than 75 per cent. heart on each of the four sides, measured across the side anywhere in the length of the piece.

(b) DOUGLAS FIR.—Shall show not less than 85 per cent. heart at any point in the length of the tie; it shall show not less than an average of 12 annual rings to the inch.

Stringers.

4. (a) LONG-LEAF YELLOW PINE.—Shall show not less than 85 per cent. heart on each of the four sides, measured across the side anywhere in the length of the piece. Sound knots less than three (3) in. in diameter shall be permitted in the vertical faces of the stringer at points not less than one-quarter the depth from the edge of the piece.

(b) DOUGLAS FIR.—Shall show not less than 85 per cent. heart on any face and not less than 70 per cent. on any edge; it shall show not less than an average of 12 annual rings to the inch. Sound knots, less than three (3) in. in diameter, shall be permitted in the vertical faces of the stringer at points not less than one-quarter the depth from the edge of the piece.

Caps and Sills.

5. (a) LONG-LEAF YELLOW PINE, WHITE, POST AND BURR OAK.—The opposite or bearing faces shall show not less than 85 per cent. heart,

* Adopted, Vol. 7, 1906, pp. 685-688, 703, 704, 714-716.

and the other two sides shall show not less than 75 per cent. heart, measured across the face anywhere in the length of the piece.

(b) Douglas Fir.—Shall show not less than 75 per cent. heart on each face, measured across the face anywhere in the length of the piece; sound sapwood shall be permitted, not exceeding two (2) in. in width at any corner. Knots must be sound and not over three (3) in. in diameter, measured on the surface of the timber, and shall not be in groups. It shall show not less than an average of 12 annual rings to the inch.

Posts.

6. (a) Long-Leaf Yellow Pine, White, Post and Burr Oak.—Shall show not less than 66 per cent. heart, measured across the face anywhere in the length of the piece. No knots shall be permitted in the corners of the post. One inch wane shall be allowed on two corners half the length of the piece.

(b) Douglas Fir.—Shall show not less than 66 per cent. heart, measured across the face anywhere in the length of the piece. No knots shall be permitted in the corners of the post; it shall show not less than an average of 12 annual rings to the inch. One inch wane shall be allowed on two corners half the length of the piece.

Longitudinal Struts or Girts.

7. (a) Long-Leaf Yellow Pine.—Shall show one side all heart; the other three sides shall show not less than 85 per cent. heart, measured across the face anywhere in the length of the piece.

(b) Douglas Fir.—Shall show one side all heart; the other three sides shall show not less than 85 per cent. heart, measured across the face anywhere on the piece; it shall show not less than an average of 12 annual rings to the inch.

Longitudinal X-Braces, Sash Braces and Sway Braces.

8. Long-Leaf Yellow Pine, Douglas Fir, White, Burr and Post Oak.—Shall show not less than 66 per cent. heart on each of the two faces anywhere in the length of the piece; no restrictions as to sap on edges.

Piling. General Requirements.

9. Piling.—All piling shall be cut from sound live trees of slow growth, firm grain, free from ring shakes, decay, large, unsound knots, or other defects that will impair their strength and durability. They shall be butt cut, above the ground swell, and be uniformly tapering from the butt to the tip. They shall be so straight that a line stretched from the center of the pile at the butt to the center of the pile at the tip will not leave the center of the pile at any point more than two (2) in. for piles 20 ft., four (4) in. for piles 30 ft., six (6) in. for piles 40 ft., and eight (8) in. for piles 50 ft. in length. No short bends shall be allowed.

Piling. General Requirements.

All knots shall be trimmed close to the body of the pile, and the bark peeled.

10. (a) White, Post, or Burr Oak.—Round piles shall be not less than 12 in. diameter, 6 ft. from the butt, and not less than 10 in. diameter at the tip for piles under 30 ft. long, nor less than 9 in. diameter for piles 30 to 39 ft. long, and not less than 8 in. diameter for piles 40 ft. long and over.

Square piles shall be of timber squared throughout their entire length, smoothly hewed; they shall be not less than 14 in. nor more than 16 in. square at the butt and not less than 10 in. square at the tip for piles under 30 ft. long, 9 in. square for piles 30 to 39 ft. long, and not less than 8 in. square for piles 40 ft. long and over. They shall show not less than 75 per cent. heart.

(b) Norway and Tamarack.—Piles shall be not less than 14 in. nor more than 18 in. in diameter at the butt, not less than 10 in. at the tip for piles under 30 ft. long, and not less than 9 in. diameter for piles 30 ft. long and over.

(c) Southern Long-Leaf Yellow Pine.—Round piles shall be not less than 14 in., nor more than 16 in. in diameter at the butt, and not less than 10 in. at the tip. They shall show not less than 80 per cent. heart on the ends.

Square piles shall be not less than 12 in. nor over 14 in. square at the butt, and not less than 8 in. square at the tip. Piles shall be hewed square, except that one inch wane will be allowed on two corners for half the length of pile. They shall show not less than 75 per cent. heart on any side for full length of pile.

(d) White Cedar.—Piles shall be not less than 14 in. in diameter at the butt, not less than 9 in. diameter at the tip when under 30 ft. long, and not less than 8 in. diameter at the tip when 30 ft. long and over. Unsound butts will be accepted if the defect is not more than 4 in. in diameter. There must be 5 in. of sound close-grained wood all around the defect.

(e) Red Cedar.—Piles shall be not less than 12 in. in diameter at the butt, not less than 9 in. diameter at the tip when under 30 ft. long, and not less than 8 in. diameter at the tip when 30 ft. long and over. Unsound butts will be accepted if the defect is not more than 3 in. in diameter. There must be 5 in. of sound close-grained wood all around the defect.

(f) Douglas Fir.—Piles shall be of either red or yellow Douglas fir. Piles under 40 ft. long shall be not less than 14 in. nor more than

18 in. in diameter at the butt, and not less than 10 in. diameter at the tip. Piles 40 ft. long and over shall be not less than 16 in. nor more than 22 in. diameter at the butt, and not less than 8 in. diameter at the tip; they shall show not less than 75 per cent. heart at the tip. Piling. General Requirements.

(g) CYPRESS.—Piles shall be red or swamp cypress. They shall be squared throughout their entire length, smoothly hewed. They shall be not less than 14 in. nor more than 16 in. square at the butt, and not less than 10 in. square at the tip for piles 30 ft. long and under, not less than 9 in. square for piles 31 to 40 ft. long, and not less than 8 in. square for piles 41 to 50 ft. long. Piles shall show all heart.

11. FOUNDATION PILING.—Piles for foundations that will always be completely submerged and piles for cofferdams, false-work and sundry temporary work may be of red oak, hickory, elm, gum or any sound timber that will stand driving and need not be peeled. Foundation piles shall be not less than 12 in. nor more than 16 in. diameter at the butt, and not less than 9 in. at the tip. Foundation Piling.

*SPECIFICATIONS FOR METALLIC DETAILS USED IN WOODEN BRIDGES AND TRESTLES.

RECOMMENDED STANDARD SPECIFICATIONS.

GENERAL REQUIREMENTS.

1. Wrought-iron shall be double-rolled, tough, fibrous and uniform in character. It shall be thoroughly welded in rolling and be free from surface defects. When tested in specimens of the form of Fig. 1 or in full-sized pieces of the same length, it shall show an ultimate strength of at least 50,000 lbs. per sq. in., an elongation of 18 per cent. in 8 in., with fracture wholly fibrous. Specimens shall bend cold, with the fiber, through 135 degrees, without sign of fracture, around a pin the diameter of which is not over twice the thickness of the piece tested. When nicked and bent, the fracture shall show at least 90 per cent. fibrous. Wrought-Iron.

2. Steel shall be made by the open-hearth process. It shall contain not over 0.04 per cent. phosphorus and not over 0.04 per cent. sulphur, when tested in specimens of the form Fig. 1 or full-sized pieces of same length. It shall have a desired ultimate strength of 50,000 lbs. per sq. in.; tensile tests of steel showing an ultimate strength within 5,000 lbs. per sq. in. of that desired will be considered satisfactory, Steel.

* Adopted, Vol. 7, 1906, pp. 692-694, 719-724.

except that, if the ultimate strength varies more than 4,000 lbs. from that desired, a retest shall be made on the same, which, to be acceptable, shall be within 5,000 lbs. of the desired ultimate; it shall have an elongation of $\frac{1{,}500{,}000}{\text{ult. tens. strength}}$ in 8 in.; it shall bend cold without fracture 180 degrees flat. The fracture of tensile test shall be silky.

Cast-Iron.

3. Cast-iron shall be made of tough gray iron, with sulphur not over 0.10 per cent. If tested on the "Arbitration Bar" of the American

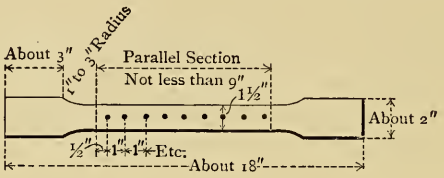


Fig. 1.

Society for Testing Materials, which is a round bar 1¼ in. in diameter and 15 in. in length, the transverse test shall be made on a supported length of 12 in. with load at the middle. The minimum breaking load so applied shall be 2,900 lbs. with a deflection of at least $\frac{1}{10}$-in. before rupture.

DETAIL SPECIFICATIONS.

Bolts.

4. Bolts shall be of wrought-iron or steel, made with square heads, standard size, the length of thread to be 2½ times the diameter of bolt. The nuts shall be made square, standard size, with thread fitting closely the thread of bolt. All threads shall be cut according to U. S. standards.

Drift Bolts.

5. Drift bolts shall be of wrought-iron or steel, with or without square head, pointed or without point, as may be called for on the plans.

Spikes.

6. Spikes shall be of wrought-iron or steel, square or round, as called for on the plans; steel wire spikes, when used for spiking planking, shall not be used in lengths more than 6 in.; if greater lengths are required, wrought or steel spikes shall be used.

Packing Spools or Separators.

7. Packing spools or separators shall be of cast-iron, made to size and shape called for on plans; the diameter of hole shall be ⅛-in. larger than diameter of packing bolts.

Cast Washers.

8. Cast washers shall be of cast-iron. The diameter shall be not less than 3½ times the diameter of bolt for which it is used, and its

thickness equal to the diameter of bolt; the diameter of hole shall be ⅛-in. larger than the diameter of the bolt.

Wrought Washers.

9. Wrought washers shall be of wrought-iron or steel, the diameter shall be not less than 3½ times the diameter of bolt for which it is used, and not less than ¼-in. thick. The hole shall be ⅛-in. larger than the diameter of the bolt.

Special Castings.

10. Special castings shall be made true to pattern, without wind, free from flaws and excessive shrinkage; size and shape to be as called for by the plans.

*SAFE UNIT STRESSES.

RECOMMENDED PRACTICE.

The following allowable unit stresses are recommended, their values being chosen so as to include the allowance for impact:

STRINGERS.—For long-leaf yellow pine and Douglas red fir: 1,200 lbs. per sq. in. on the extreme fibers in bending and 120 lbs. per sq. in. for shear parallel to the fibers.

CAPS AND SILLS.—For long-leaf yellow pine and Douglas red fir: 300 lbs. per sq. in. for bearing on the side of the fibers.

For white, post and burr oak: 500 lbs. per sq. in.

POSTS AND PILES.—For long-leaf yellow pine and Douglas red fir: $1{,}200 - 18\frac{l}{d}$ lbs. per sq. in. for the average compression on the cross-section, in which "l" is the length and "d" the least diameter of the column, both expressed in inches.

For white, post and burr oak: $1{,}000 - 15\frac{l}{d}$ lbs. per sq. in.

For Norway pine, cypress and cedar: $800 - 12\frac{l}{d}$ lbs. per sq. in.

* Adopted, Vol. 7, 1906, pp. 694, 720-722.

*SPECIFICATIONS FOR WORKMANSHIP FOR PILE AND FRAME TRESTLES TO BE BUILT UNDER CONTRACT.

RECOMMENDED STANDARD SPECIFICATIONS.

SITE.

1. The trestle to be built under these specifications is located on the line of .....Railroad at ..... County of ..... State of .....

GENERAL DESCRIPTION.

2. The work to be done under these specifications covers the driving, framing and erection of a .....track wooden trestle about ..... feet long and an average of ..... feet high.

GENERAL CLAUSES.

3. The contractor shall furnish all necessary labor, tools, machinery, supplies, temporary staging and outfit required. He shall build the complete trestle ready for the track rails, in a workmanlike manner, in strict accordance with the plans and the true intent of these specifications, to the satisfaction and acceptance of the engineer of the railroad company.

4. The workmanship shall be of the best quality in each class of work. All details, fastenings and connections shall be of the best method of construction in general use on first-class work.

5. Holes shall be bored for all bolts. The depth of the hole and the diameter of the auger to be as specified by the engineer.

6. All framing shall be accurately fitted; no blocking or shimming will be allowed in making joints. All timbers shall be cut off with the saw; no ax to be used.

7. All joints and points of bearing, for which no fastening is shown on the plans, shall be fastened as specified by the engineer.

8. The engineer or his authorized agents shall have full power to cause any inferior work to be condemned, and taken down or altered, at the expense of the contractor. Any material destroyed by the con-

* Adopted, Vol. 8, 1907, pp. 397-400, 442-450.

tractor on account of inferior workmanship or carelessness of his men is to be replaced by the contractor at his own expense.

9. Figures shown on the plans shall govern in preference to scale measurements; if any discrepancies should arise or irregularities be discovered in the plans, the contractor shall call on the engineer for instructions. These specifications and the plans are intended to co-operate, and if any question arises as to the proper interpretation of the plans or specifications, it shall be referred to the engineer for a ruling.

10. The contractor shall, when required by the engineer, furnish a satisfactory watchman to guard the work.

11. On the completion of the work, all refuse material and rubbish that may have accumulated on top or under and near the trestle, by reason of its construction, shall be removed by the contractor.

DETAIL SPECIFICATIONS.

12. All piles shall be carefully selected to suit the place and ground where they are to be driven. When required by the engineer, pile butts shall be banded with iron or steel for driving, and the tips with suitable iron or steel shoes; such shoes will be furnished by the railroad company.

13. All piles shall be driven to a firm bearing, satisfactory to the engineer, or until five blows of a hammer weighing 3,000 pounds, falling 15 feet (or a hammer and fall producing the same mechanical effect), are required to cause an average penetration of one-half (½) in. per blow, except in soft bottom, where special instructions will be given.

14. Batter piles shall be driven to the inclination shown by the plans, and shall require but slight bending before framing.

15. The butts of all piles in a bent shall be sawed off to one plane and trimmed so as not to leave any horizontal projection outside of the cap.

16. Piles injured in driving, or driven out of place, shall either be pulled out or cut off, and replaced by new piles.

17. Caps shall be sized over the piles or posts to a uniform thickness and even bearing on piles or posts. The side with most sap shall be placed downward. Caps.

18. Posts shall be sawed to proper length for their position (vertical or batter), and to an even bearing on cap and sill. Posts.

19. Sills shall be sized at the bearing of posts to one plane, Sills.

Sway Braces.

20. All sway bracing shall be properly framed and securely fastened to piles or posts. When necessary for pile bents, filling pieces shall be used between the braces and the piles on account of the variation in size of piles, and securely fastened and faced to obtain a bearing against all piles.

Longitudinal Braces.

21. Longitudinal X-braces shall be properly framed and securely fastened to piles or posts.

Girts.

22. Girts shall be properly framed and securely fastened to caps, sub-sills, posts or piles, as the plans may require.

Stringers.

23. Stringers shall be sized to a uniform height at supports. The edges with most sap shall be placed downward.

Jack Stringers.

24. Jack stringers, if required on the plans, shall be neatly framed on caps, and their tops shall be in the same plane as the track stringers.

Ties.

25. Ties shall be framed to a uniform thickness over bearings, and shall be placed with the rough side upward. They shall be spaced regularly, cut to even length and line, as called for on the plans.

Guard Rails.

26. Timber guard rails shall be framed as called for on the plans, laid to line and to a uniform top surface. They shall be firmly fastened to the ties as required.

Bulkheads.

27. Bulkheads shall be of sufficient dimensions to keep the embankment clear of the caps, stringers and ties, at the end bents of the trestle. There shall be a space of not less than two (2) inches between the back of the end bent and the face of the bulkhead. The projecting ends of the bulkhead shall be sawed off to conform with the slope of the embankment, unless otherwise specified.

Time of Completion.

28. The work shall be completed in all its parts on or before .....A. D. 19.....

Payments.

29. Payments will be made under the usual regulations of the railroad company.

COMMITTEE NO. VIII.

MASONRY.

*MASONRY.

DEFINITIONS OF MASONRY TERMS APPLIED TO RAILROAD CONSTRUCTION.

MASONRY.—All constructions of stone or kindred substitute materials in which the separate pieces are either placed together, with or without cementing material to join them, or where not separately placed, are encased in a matrix of firmly cementing material.

CLASSIFICATION OF MASONRY.

KIND.	Material.	Description.	Manner of Work.	Dressing.	
				Joints or Beds.	Face or Surface.
Bridge and Retaining Wall.	Stone	Dimension	Coursed	Smooth	Smooth, Rock-faced
		Ashlar	Coursed, Broken-coursed	Smooth, Fine pointed, Rough p'ted	Smooth, Rock-faced
		Rubble	Uncoursed	Rough p'ted, Scabbled	Rock-faced
	Concrete	Reinforced, Plain, Rubble			
Arch.....	Stone	Ashlar	Coursed	Smooth, Fine pointed	Smooth, Rock-faced
		Rubble	Uncoursed	Rough p'ted, Scabbled	Rock-faced
	Concrete	Reinforced, Plain			
	Brick	No. 1	English Bond, Flemish Bond		
Culvert.....	Stone	Rubble, Dry	Uncoursed	Rough p'ted, Scabbled	Rock-faced
	Concrete	Reinforced, Plain, Rubble			
Dry.....	Stone	Rubble	Uncoursed		

* Adopted, Vol. 7, 1906, pp. 596-601, 619.

Masonry, Bridge and Retaining Wall.—Masonry of stone or concrete, designed to carry the end of a bridge span or to retain the abutting earth, or both.

Masonry, Arch.—That portion of the masonry in the arch ring only, or between the intrados and the extrados.

Masonry, Culvert.—Flat-top masonry structure of stone or concrete, designed to sustain the fill above and to permit of the free passage of water.

Masonry, Dry.—Masonry in which stones are built up without the use of mortar.

CONCRETE.

Concrete.—A compact mass of broken stone, gravel or other suitable material assembled together with cement mortar and allowed to harden.

Reinforced Concrete.—Concrete which has been reinforced by means of metal in some form, so as to develop the compressive strength of the concrete.

Rubble Concrete.—Concrete in which rubble stone are imbedded.

BRICK.

Brick.—No. 1.—Hard burned brick, absorption not exceeding 2 per cent. by weight.

CEMENT.

Cement.—A preparation of calcined clay and limestone, or their equivalents, possessing the property of hardening into a solid mass when moistened with water. Cements are divided into four classes: Portland, Natural, Puzzolan and Silica cement. (See each.)

Portland Cement.—This term shall be applied to the finely pulverized product resulting from the calcination to incipient fusion of an intimate mixture of properly proportioned argillaceous and calcareous materials, and to which no addition greater than 3 per cent. has been made subsequent to calcination.

Natural Cement.—This term shall be applied to the finely pulverized product resulting from the calcination of an argillaceous limestone at a temperature only sufficient to drive off the carbonic acid gas.

Puzzolan.—An intimate mixture of pulverized granulated furnace slag and slaked lime, which, without further calcination, possesses hydraulic properties.

COURSED AND BOND.

COURSED.—Laid with continuous bed joints.

BROKEN COURSED.—Laid with parallel, but not continuous, bed joints.

UNCOURSED.—Laid without regard to courses.

ENGLISH BOND.—That disposition of bricks in a structure in which each course is composed entirely of headers or of stretchers.

FLEMISH BOND.—That disposition of bricks in a structure in which the headers and stretchers alternate in each course, the header being so placed that the outer end lies on the middle of a stretcher in the course below.

DRESSING.

DRESSING.—The finish given to the surface of stones or to concrete.

SMOOTH.—Having surface, the variations of which do not exceed one-sixteenth inch from the pitch line.

FINE POINTED.—Having irregular surface, the variations of which do not exceed one-quarter inch from the pitch line.

ROUGH POINTED.—Having irregular surface, the variations of which do not exceed one-half inch from the pitch line.

SCABBLED.—Having irregular surface, the variations of which do not exceed three-quarters inch from the pitch line.

ROCK-FACED.—Presenting irregular projecting face, without indications of tool mark.

DESCRIPTIVE WORDS.

ABUTMENT.—A supporting wall carrying the end of a bridge or span and sustaining the pressure of the abutting earth. The abutment of an arch is commonly called a bench wall.

ARRIS.—The external edge formed by two surfaces, whether plain or curved, meeting each other.

ASHLAR.—A squared or cut block of stone with rectangular dimensions.

BACKING.—That portion of a masonry wall or structure built in the rear of the face. It must be attached to the face and bonded with it. It is usually of a cheaper grade of work than the face.

BATTER.—The slope or inclination of the face or back of a wall from a vertical line.

BED.—The top and bottom of a stone. (See Course Bed; Natural Bed; Foundation Bed.)

BED JOINT.—A horizontal joint, or one perpendicular to the line of pressure.

BENCH WALL.—The abutment from which an arch springs.

BOND.—The mechanical disposition of stone, brick or other building blocks by overlapping to break joints.

BUILD.—A vertical joint.

CENTERING.—A temporary support used in arch construction. (Also called centers.)

CLAMP.—An instrument for lifting stone so designed that its grip on the surface of the stone is increased as the load is applied. That portion engaging the stone is of wood attached to a steel shoe, which in turn is hinged to the shank of the clamp in such a manner as to adjust itself to the surface of the body lifted.

COPING.—A top course of stone or concrete, generally slightly projecting, to shelter the masonry from the weather, or to distribute the pressure from exterior loading.

COURSE.—Each separate layer in stone, concrete or brick masonry.

COURSE BED.—Stone, brick or other building material in position, upon which other material is to be laid.

CRAMPS.—Bars of iron having the ends turned at right angles to the body of the bar which enter holes in the upper side of adjacent stones.

CULVERT.—A small covered passage for water under a roadway or embankment.

DIMENSION STONE.—(1) A block of stone cut to specified dimensions.

DIMENSION STONE.—(2) Large blocks of stone quarried to be cut to specified dimensions.

DOWELS.—(a) Straight bars of iron which enter a hole in the upper side of one stone and also a hole in the lower side of the stone next above.

DOWEL.—(b) A two-piece steel instrument used in lifting stone. The dowel engages the stone by means of two holes drilled into the stone at an angle of about 45 degrees pointing toward each other. The dowel is not keyed in place.

DRAFT.—A line on the surface of a stone cut to the breadth of the chisel.

EXPANSION JOINT.—A vertical joint or space to allow for temperature changes.

EXTRADOS.—The upper or convex surface of an arch.

FACE.—The exposed surface in elevation.

FACING.—In concrete: (1) A rich mortar placed on the exposed surfaces to make a smooth finish.

(2) Shovel facing by working the mortar of concrete to the face.

FINAL SET.—A stage of the process of setting marked by certain hardness. (See Cement Specifications.)

FLUSH.—(Adj.) Having the surface even or level with an adjacent surface.

(Verb.) (1) To fill. (2) To bring to a level. (3) To force water to the surface of mortar or concrete by compacting or ramming.

FOOTING.—A projecting bottom course.

FORM.—A temporary structure for giving concrete a desired shape.

FOUNDATION.—(1) That portion of a structure, usually below the surface of the ground, which distributes the pressure upon its support.

(2) Also applied to the natural support itself; rock, clay, etc.

FOUNDATION BED.—The surface on which a structure rests.

GROUT.—A thin mortar either poured or applied with a brush.

HEADER.—A stone which has its greatest length at right angles to the face of the wall, and which bonds the face stones to the backing.

INITIAL SET.—An early stage of the process of setting, marked by certain hardness. (See Cement Specifications.)

INTRADOS.—The inner or narrow concave surface of an arch.

JOINT.—The narrow space between adjacent stones, bricks or other building blocks, usually filled with mortar.

LAGGING.—Strips used to carry and distribute the weight of an arch to the ribs or centering during its construction.

LEWIS.—A four-piece steel instrument used in lifting stone. (The lewis engages the stone by means of a triangular-shaped hole into which it is keyed.)

LOCK.—Any special device or method of construction used to secure a bond in the work.

MORTAR.—A mixture of sand, cement or lime, and water, used to cement the various stones or brick in masonry, or to cover the surface of same.

NATURAL BED.—The surfaces of a stone parallel to its stratification.

PARAPET.—A wall or barrier on the edge of an elevated structure for protection or ornament.

PAVING.—Regularly placed stone or brick forming a floor.

Pier.—An intermediate support for arches or other spans.

Pitch.—(Verb) To square a stone.

Pitched.—Having the arris clearly defined by a line beyond which the rock is cut away by the pitching chisel so as to make approximately true edges.

Pointing.—Filling joints or defects in the face of a masonry structure.

Retaining Wall.—A wall for sustaining the pressure of earth or filling deposited behind it.

Ring Stones.—The end voussoirs of an arch.

Riprap.—Rough stone of various sizes placed compactly or irregularly to prevent scour by water.

Rubble.—Field stone or rough stone as it comes from the quarry. When it is of large or massive size it is termed block rubble.

Rubbed.—A fine finish made by rubbing with grit or sandstone.

Set.—(Noun) The change from a plastic to a solid or hard state.

Slope Wall.—A wall to protect the slope of an embankment or cut.

Soffit.—The under side of a projection.

Spall.—(Noun) A chip or small piece of stone broken from a large block.

Spandrel Wall.—The wall at the end of an arch above the springing line and extrados of the arch and below the coping or the string course.

Stretcher.—A stone which has its greatest length parallel to the face of the wall.

Voussoirs.—The individual stones forming an arch. They are always of a truncated wedge form.

Wing Wall.—An extension of an abutment wall to retain the adjacent earth.

*MASONRY.

GENERAL DEFINITION.

The following definition is adopted by this Association as a comprehensive definition to cover any kind of masonry, and with the further recommendation that in usual practice the word "masonry" be qualified by some proper term to more particularly describe the kind of masonry under consideration:

"Masonry, in its widest sense, includes all constructions of stone or kindred substitute materials, in which the separate pieces are either

* Adopted, Vol. 3, 1902, pp. 310, 347.

placed together, with or without cementing material to join them; or, when not separately placed, are encased in a matrix of firmly cementing material."

*MASONRY SPECIFICATIONS.

RECOMMENDED PRINCIPLES OF PRACTICE.

This Association recommends as good practice that railroad companies prepare and use specifications complete in themselves for all kinds of masonry, to be in such form that they may be attached to and form part of specifications and contracts for other railroad construction when desirable.

†PORTLAND CEMENT CONCRETE.

RECOMMENDED STANDARD SPECIFICATIONS.

Cement. 1. Cement shall be Portland, either American or foreign, which will meet the requirements of the standard specifications.

Sand. 2. Sand shall be clean, sharp, coarse, and of grains varying in size. It shall be free from sticks and other foreign matter, but it may contain clay or loam not to exceed five (5) per cent. Crusher dust, screened to reject all particles over one-quarter (¼) in. in diameter, may be used instead of sand, if approved by the engineer.

Stone. 3. Stone shall be sound, hard and durable, crushed to sizes not exceeding two inches in any direction. For reinforced concrete sizes usually are not to exceed three-quarters (¾) in. in any direction, but may be varied to suit character of reinforcing material.

Gravel. 4. Gravel shall be composed of clean pebbles of hard and durable stone of sizes not exceeding two inches in diameter, and shall be free from clay and other impurities except sand. When containing sand in any considerable quantity, the amount of sand per unit of volume of gravel shall be determined accurately, to admit of the proper proportion of sand being maintained in the concrete mixture.

Water. 5. Water shall be clean and reasonably clear, free from sulphuric acid or strong alkalies.

Mixing by Hand. 6. (a) Tight platforms shall be provided of sufficient size to accommodate men and materials for the progressive and rapid mixing of at least two batches of concrete at the same time. Batches shall not

* Adopted, Vol. 3, 1902, pp. 310, 348.

† Adopted, Vol. 3, 1902, pp. 304-306; Vol. 4, 1903, pp, 386-389, 394, 436-443; Vol. 5, 1904, pp. 610-613, 618, 619, 650-666.

Mixing by Hand.

exceed one cubic yard each, and smaller batches are preferable, based upon a multiple of the number of sacks of cement to the barrel.

(b) Spread the sand evenly upon the platform, then the cement upon the sand, and mix thoroughly until of an even color. Add all the water necessary to make a thin mortar and spread again; add the gravel if used, and finally the broken stone, both of which, if dry, should first be thoroughly wet down. Turn the mass with shovels or hoes until thoroughly incorporated, and all the gravel and stone is covered with mortar; this will probably require the mass to be turned four times.

(c) Another approved method, which may be permitted at the option of the engineer in charge is to spread the sand, then the cement and mix dry, then the gravel or broken stone; add water and mix thoroughly as above.

Mixing by Machine.

7. A machine mixer shall be used whenever the volume of work will justify the expense of installing the plant. The necessary requirements for the machine will be that a precise and regular proportioning of materials can be controlled and that the product delivered shall be of the required consistency and thoroughly mixed.

Consistency.

8. The concrete shall be of such consistency that when dumped in place it will not require much tamping. It shall be spaded down and tamped sufficiently to level off, and the water should rise freely to the surface.

Forms.

9. (a) Forms shall be well built, substantial and unyielding, properly braced or tied together by means of wire or rods, and shall conform to lines given.

(b) For all important work, the lumber used for face work shall be dressed on one side and both edges to a uniform thickness and width, and shall be sound and free from loose knots, secured to the studding or uprights in horizontal lines.

(c) For backings and other rough work undressed lumber may be used.

(d) Where corners of the masonry and other projections liable to injury occur, suitable moldings shall be placed in the angles of the forms to round or bevel them off.

(e) Lumber once used in forms shall be cleaned before being used again.

(f) The forms must not be removed within thirty-six hours after all the concrete in that section has been placed. In freezing weather

they must remain until the concrete has had a sufficient time to become thoroughly hardened.

(g) In dry but not freezing weather, the forms shall be drenched with water before the concrete is placed against them.

Disposition.

10. (a) Each layer shall be left somewhat rough to insure bonding with the next layer above; and, if it be already set, shall be thoroughly cleaned and scrubbed with coarse brushes and water before the next layer is placed upon it.

(b) Concrete shall be deposited in the molds in layers of such thickness and position as shall be specified by the engineer in charge. Temporary planking shall be placed at ends of partial layers, so that none shall run out to a thin edge. In general, excepting in arch work, all concrete must be deposited in horizontal layers of uniform thickness throughout.

(c) The work shall be carried up in sections of convenient length and each section completed without intermission.

(d) In no case shall work on a section stop within 18 inches of the top.

(e) Concrete shall be placed immediately after mixing, and any having an initial set shall be rejected.

Expansion Joints.

11. (a) In exposed work, expansion joints may be provided at intervals of 30 to 100 ft., as the character of the structure may require.

(b) A temporary vertical form or partition of plank shall be set up and the section behind completed as though it were the end of the structure. The partition shall be removed when the next section is begun, and the new concrete placed against the old without mortar flushing. Locks shall be provided if directed or called for by the plans.

(c) In reinforced concrete the length of these sections may be materially increased at the option of the engineer.

Facing.

12. (a) The facing will be made by carefully working the coarse material back from the form by means of a shovel, bar or similar tool, so as to bring the excess mortar of the concrete to the face.

(b) About one inch of mortar (not grout) of the same proportions as used in the concrete may be placed next to the forms immediately in advance of the concrete.

(c) Care must be taken to remove from the inside of the forms any dry mortar in order to secure a perfect face.

Proportioning.

13. The proportion of the materials in the concrete shall be as specifically called for by the contract, or as set forth herein, upon the lines

Proportioning.

left for that purpose; the volume of cement to be based upon the actual cubic contents of one barrel of specified weight.

STRUCTURE.	Parts by Volume			
	Cement	Sand	Gravel	Broken Stone

Finishing.

14. (a) After the forms are removed, which should generally be as soon as possible after the concrete is sufficiently hardened, any small cavities or openings in the face shall be neatly filled with mortar, if necessary in the opinion of the engineer. Any ridges due to cracks or joints in the lumber shall be rubbed down with chisel or wooden float. The entire face shall then be washed with a thin grout of the consistency of whitewash, mixed in the same proportion as the mortar of the concrete. The wash shall be applied with a brush. The earlier the above operations are performed the better will be the result.

(b) The tops of bridge seats, pedestals, copings, wing walls, etc., when not finished with natural stone coping, shall be finished with a smooth surface composed of one part cement to two parts of granite, or other suitable screenings or sand, applied in a layer one-half (½) to one (1) in. thick. This must be put in place with the last course of concrete.

Waterproofing.

15. Where waterproofing is required, a thin coat of mortar or grout shall be applied for a finishing coat, upon which shall be placed a covering of suitable waterproofing material.

Freezing Weather.

16. Ordinarily concrete to be left above the surface of the ground

shall not be constructed in freezing weather. Portland cement concrete, however, may be built under these conditions by special instructions. In this case the sand, water and broken stone shall be heated, and in severe cold, salt shall be added in the proportion of about two pounds per cubic yard.

Reinforced Concrete.

17. Where concrete is deposited in connection with metal reinforcing, the greatest care must be taken to insure the coating of the metal with mortar, and the thorough compacting of the concrete around the metal. Whenever it is practicable the metal shall be placed in position first. This can usually be done in the case where the metal occurs in the bottoms of the forms, by supporting the metal on transverse wires, or otherwise, and then flushing the bottoms of the forms with cement mortar, so as to get the mortar under the metal, and depositing the concrete immediately afterward. The mortar for flushing the bars shall be composed of one part cement and two parts sand. The metal used in the concrete shall be free from dirt, oil or grease. All mill scale shall be removed by hammering the metal, or, preferably by pickling the same in a weak solution of muriatic acid. No salt shall be used in reinforced concrete when laid in freezing weather.

*EFFICIENCY OF CONCRETE BACKING FOR STONE FACE WORK.

RECOMMENDED PRINCIPLES OF PRACTICE.

Under certain conditions the use of concrete backing for stone face work is desirable, and is considered good practice when economical.

†IMBEDDING LARGE STONES IN INTERIOR OF HEAVY CONCRETE STRUCTURES.

RECOMMENDED PRINCIPLES OF PRACTICE.

Imbedding large stones in the interior of heavy concrete structures is recommended as good practice when a saving would result, and when the thickness of structure is not less than four (4) ft.

* Adopted, Vol. 6, 1905, pp. 701, 702, 723, 728.
† Adopted, Vol. 6, 1905, pp. 702, 703, 723, 728.

*THE USE OF CONCRETE UNDER BRIDGE SEATS IN PLACE OF STONE PEDESTALS.

RECOMMENDED PRINCIPLES OF PRACTICE.

Concrete, either plain or reinforced, is recommended as suitable for bridge seats or pedestal caps.

†ECONOMY AND ADVISABILITY OF SUBSTITUTING REINFORCED CONCRETE FOR THE COMMON FORMS OF CONSTRUCTION FOR SMALL OPENINGS.

RECOMMENDED PRINCIPLES OF PRACTICE.

Good practice permits the substituting of reinforced concrete for the common forms of construction for small openings.

‡SPECIFICATIONS FOR NATURAL AND PORTLAND CEMENT.

RECOMMENDED STANDARD SPECIFICATIONS.

(Standard Specifications for Cement adopted by a Joint Committee, embracing representatives from the American Society of Civil Engineers, American Society for Testing Materials, American Institute of Architects, Engineer Department of United States Army, Association of Portland Cement Manufacturers, and American Railway Engineering and Maintenance of Way Association.)

GENERAL OBSERVATIONS.

1. These remarks have been prepared with a view of pointing out the pertinent features of the various requirements and the precautions to be observed in the interpretation of the results of the tests.

2. The Committee would suggest that the acceptance or rejection under these specifications be based on tests made by an experienced person having the proper means for making the tests.

Specific Gravity.

3. Specific gravity is useful in detecting adulteration or underburning. The results of tests of specific gravity are not necessarily conclusive as an indication of the quality of a cement, but when in combination with the results of other tests may afford valuable indications.

Fineness.

4. The sieves should be kept thoroughly dry.

* Adopted, Vol. 6, 1905, pp. 703, 724, 728, 729.

† Adopted, Vol. 6, 1905, pp. 703, 704, 724, 728, 729.

‡ Adopted, Vol. 4, 1903, pp. 389-436, 443; Vol. 5, 1904, pp. 605-610; Vol. 6, 1905, pp. 704-718, 723, 724, 726-728.

Time of Setting.

5. Great care should be exercised to maintain the test pieces under as uniform conditions as possible. A sudden change or wide range of temperature in the room in which the tests are made, a very dry or humid atmosphere, and other irregularities vitally affect the rate of setting.

Tensile Strength.

6. Each consumer should fix the minimum requirements for tensile strength to suit his own conditions. They shall, however, be within the limits stated.

Constancy of Volume.

7. The tests for constancy of volume are divided into two classes, the first normal, the second accelerated. The latter should be regarded as a precautionary test only, and not infallible. So many conditions enter into the making and interpreting of it that it should be used with extreme care.

8. In making the pats the greatest care should be exercised to avoid initial strains due to molding or too rapid drying out during the first twenty-four hours. The pats should be preserved under the most uniform conditions possible, and rapid changes of temperature should be avoided.

9. The failure to meet the requirements of the accelerated tests need not be sufficient cause for rejection. The cement may, however, be held for twenty-eight days, and a retest made at the end of that period. Failure to meet the requirements at this time should be considered sufficient cause for rejection, although in the present state of our knowledge it cannot be said that such failure necessarily indicates unsoundness, nor can the cement be considered entirely satisfactory simply because it passes the tests.

STANDARD SPECIFICATIONS FOR CEMENT.

GENERAL CONDITIONS.

1. All cement shall be inspected.

2. Cement may be inspected either at the place of manufacture or on the work.

3. In order to allow ample time for inspecting and testing, the cement shall be stored in a suitable weather-tight building having the floor properly blocked or raised from the ground.

4. The cement shall be stored in such a manner as to permit easy access for proper inspection and identification of each shipment.

5. Every facility shall be provided by the contractor and a period of at least twelve days allowed for the inspection and necessary tests.

6. Cement shall be delivered in suitable packages with the brand and name of manufacturer plainly marked thereon.

7. A bag of cement shall contain 94 pounds of cement net. Each barrel of Portland cement shall contain four bags, and each barrel of Natural cement shall contain three bags of the above net weight.

8. Cement failing to meet the seven-day requirements may be held awaiting the results of the twenty-eight day tests before rejection.

9. All tests shall be made in accordance with the methods proposed by the Committee on Uniform Tests of Cement of the American Society of Civil Engineers, presented to the Society January 21, 1903, and amended January 20, 1904, with all subsequent amendments thereto. (See addendum to these specifications.)

10. The acceptance or rejection shall be based on the following requirements:

NATURAL CEMENT.

Definition.

11. This term shall be applied to the finely pulverized product resulting from the calcination of an argillaceous limestone at a temperature only sufficient to drive off the carbonic acid gas.

Specific Gravity.

12. The specific gravity of the cement, thoroughly dried at 100° C., shall not be less than 2.8.

Fineness.

13. It shall leave by weight a residue of not more than 10 per cent. on the No. 100, and 30 per cent. on the No. 200 sieve.

Time of Setting.

14. It shall develop initial set in not less than ten minutes, and hard set in not less than thirty minutes, nor more than three hours.

Tensile Strength.

15. The minimum requirements for tensile strength for briquettes one inch square in cross-section shall be within the following limits, and shall show no retrogression in strength within the periods specified:*

Age.	*Neat Cement.*	Strength.
24 hours	in moist air	50-100 lbs.
7 days	(1 day in moist air, 6 days in water)	100-200 lbs
28 days	(1 day in moist air, 27 days in water)	200-300 lbs.
	One Part Cement, three Parts Standard Sand.	
7 days	(1 day in moist air, 6 days in water)	25- 75 lbs.
28 days	(1 day in moist air, 27 days in water)	75-150 lbs.

Constancy of Volume.

16. Pats of neat cement about three (3) in. in diameter, one-half (½) in. thick at center, tapering to a thin edge, shall be kept in moist air for a period of twenty-four hours.

* For example, the minimum requirement for the twenty-four hour neat cement tests should show some specified value within the limits of 50 and 100 pounds, and so on for each period stated.

(a) A pat is then kept in air of normal temperature.

(b) Another is kept in water maintained as near 70° F. as practicable.

17. These pats are observed at intervals for at least 28 days, and, to satisfactorily pass the tests, should remain firm and hard and show no signs of distortion, checking, cracking or disintegrating.

PORTLAND CEMENT.

Definition.

18. This term shall be applied to the finely pulverized product resulting from the calcination to incipient fusion of an intimate mixture of properly proportioned argillaceous and calcareous materials, and to which no addition greater than 3 per cent. has been made subsequent to calcination.

Specific Gravity.

19. The specific gravity of the cement, thoroughly dried at 100° C., shall be not less than 3.10.

Fineness.

20. It shall leave by weight a residue of not more than 8 per cent. on the No. 100, and not more than 25 per cent. on the No. 200 sieve.

Time of Setting.

21. It shall develop initial set in not less than thirty minutes, but must develop hard set in not less than one hour, nor more than ten hours.

Tensile Strength.

22. The minimum requirements for tensile strength for briquettes one-inch square in cross-section shall be within the following limits, and shall show no retrogression in strength within the periods specified:*

Age.	*Neat Cement.*	Strength.
24 hours	in moist air	150-200 lbs.
7 days	(1 day in moist air, 6 days in water)	450-550 lbs.
28 days	(1 day in moist air, 27 days in water)	550-650 lbs.
	One Part Cement, Three Parts Standard Sand.	
7 days	(1 day in moist air, 6 days in water)	150-200 lbs.
28 days	(1 day in moist air, 27 days in water)	200-300 lbs.

Constancy of Volume.

23. Pats of neat cement about three (3) in. in diameter, one-half (½) in. thick at the center, and tapering to a thin edge, shall be kept in moist air for a period of twenty-four hours.

(a) A pat is then kept in air at normal temperature and observed at intervals for at least 28 days.

(b) Another pat is kept in water maintained as near 70° F. as practicable, and observed at intervals for at least 28 days.

* For example, the minimum requirement for the twenty-four hour neat cement tests should show some specified value within the limits of 150 and 200 pounds, and so on for each period stated.

Constancy of Volume.

(c) A third pat is exposed in any convenient way in an atmosphere of steam, above boiling water, in a loosely closed vessel for five hours.

24. These pats, to satisfactorily pass the requirements, shall remain firm and hard and show no signs of distortion, checking, cracking or disintegrating.

Sulphuric Acid and Magnesia.

25. The cement shall not contain more than 1.75 per cent. of anhydrous sulphuric acid (SO_3), nor more than 4 per cent. of magnesia (MgO).

ADDENDUM.

ABSTRACT OF METHODS RECOMMENDED BY THE SPECIAL COMMITTEE ON UNIFORM TESTS OF CEMENT OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

SAMPLING.

Selection of Sample.

1. The sample shall be a fair average of the contents of the package; it is recommended that, where conditions permit, one barrel in every ten be sampled.

2. All samples should be passed through a sieve having twenty meshes per linear inch, in order to break up lumps and remove foreign material; this is also a very effective method for mixing them together in order to obtain an average. For determining the characteristics of a shipment of cement, the individual samples may be mixed and the average tested; where time will permit, however, it is recommended that they be tested separately.

Method of Sampling.

3. Cement in barrels should be sampled through a hole made in the center of one of the staves, midway between the heads, or in the head, by means of an auger or a sampling iron similar to that used by sugar inspectors. If in bags, it should be taken from surface to center.

CHEMICAL ANALYSIS.

Method.

4. As a method to be followed for the analysis of cement, that proposed by the Committee on Uniformity in the Analysis of Materials for the Portland Cement Industry, of the New York Section of the Society for Chemical Industry, and published in the *Journal* of the Society for January 15, 1902, is recommended.

SPECIFIC GRAVITY.

Apparatus and Method.

5. The determination of specific gravity is most conveniently made with Le Chatelier's apparatus. This consists of a flask (*D*), Fig. 1, of 120 cu. cm. (7.32 cu. in.) capacity, the neck of which is about 20 cm.

(7.87 in.) long; in the middle of this neck is a bulb (*C*), above and below which are two marks (*F*) and (*E*); the volume between these marks is 20 cu. cm. (1.22 cu. in.). The neck has a diameter of about

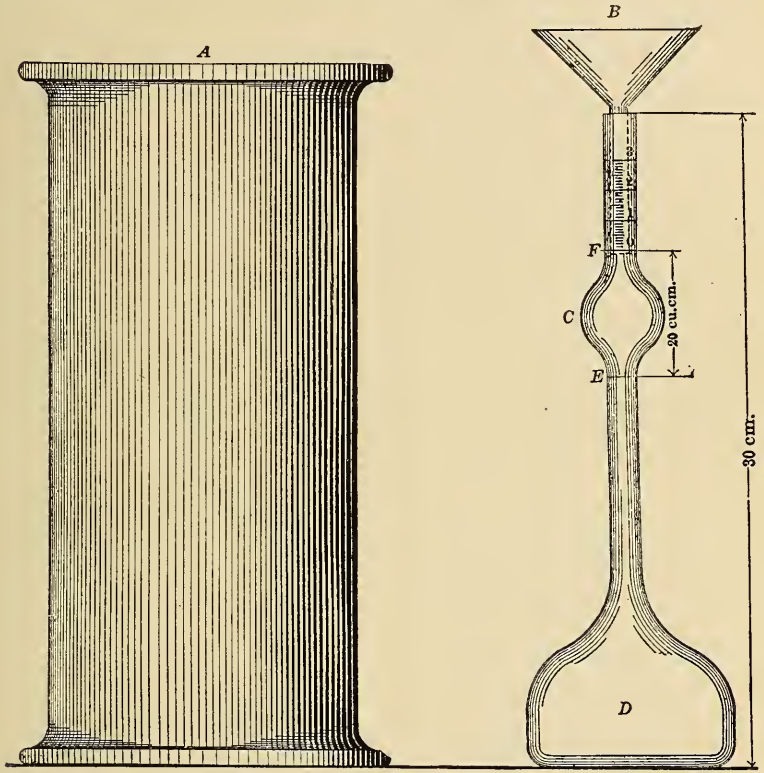


Fig. 1.—Le Chatelier's Specific Gravity Apparatus.

9 mm. (0.35 in.), and is graduated into tenths of cubic centimeters above the mark (*F*).

6. Benzine (62° Baumé naphtha), or kerosene free from water, should be used in making the determination.

7. The specific gravity can be determined in two ways:

(a) The flask is filled with either of these liquids to the lower mark (*E*), and 64 gr. (2.25 oz.) of powder, previously dried at 100° C. (212° F.) and cooled to the temperature of the liquid, is gradually introduced through the funnel (*B*) [the stem of which extends into the flask to the top of the bulb (*C*)], until the upper mark (*F*) is reached. The

Apparatus and Method.

difference in weight between the cement remaining and the original quantity (64 gr.) is the weight which has displaced 20 cu. cm.

8. (b) The whole quantity of the powder is introduced, and the level of the liquid rises to some division of the graduated neck. This reading plus 20 cu. cm. is the volume displaced by 64 gr. of the powder.

9. The specific gravity is then obtained from the formula:

$$\text{Specific Gravity} = \frac{\text{Weight of Cement}}{\text{Displaced Volume}}.$$

10. The flask, during the operation, is kept immersed in water in a jar (*A*), in order to avoid variations in the temperature of the liquid. The results should agree within 0.01.

11. A convenient method for cleaning the apparatus is as follows: The flask is inverted over a large vessel, preferably a glass jar, and shaken vertically until the liquid starts to flow freely; it is then held still in a vertical position until empty; the remainng traces of cement can be removed in a similar manner by pouring into the flask a small quantity of clean liquid and repeating the operation.

FINENESS.

Apparatus.

12. The sieves should be circular, about 20 cm. (7.87 in.) in diameter, 6 cm. (2.36 in.) high, and provided with a pan 5 cm. (1.97 in.) deep, and a cover.

13. The wire cloth should be woven (not twilled) from brass wire having the following diameters:

No. 100, 0.0045 in.; No. 200, 0.0024 in.

14. This cloth should be mounted on the frames without distortion; the mesh should be regular in spacing and be within the following limits:

No. 100, 96 to 100 meshes to the linear inch.
No. 200, 188 to 200 meshes to the linear inch.

Method.

15. Fifty grams (1.76 oz.) or 100 gr. (3.52 oz.) should be used for the test, and dried at a temperature of 100° C. (212° F.) prior to sieving.

16. The thoroughly dried and coarsely screened sample is weighed and placed on the No. 200 sieve, which, with pan and cover attached, is held in one hand in a slightly inclined position, and moved forward and backward, at the same time striking the side gently with the palm of the other hand, at the rate of about 200 strokes per minute. The operation is continued until not more than one-tenth of 1 per cent. passes through

after one minute of continuous sieving. The residue is weighed, then placed on the No. 100 sieve and the operation repeated. The work may be expedited by placing in the sieve a small quantity of large shot. The results should be reported to the nearest tenth of 1 per cent.

NORMAL CONSISTENCY.

17. This can best be determined by means of *Vicat Needle Apparatus,* which consists of a frame (*K*), Fig. 2, bearing a movable rod **Method.**

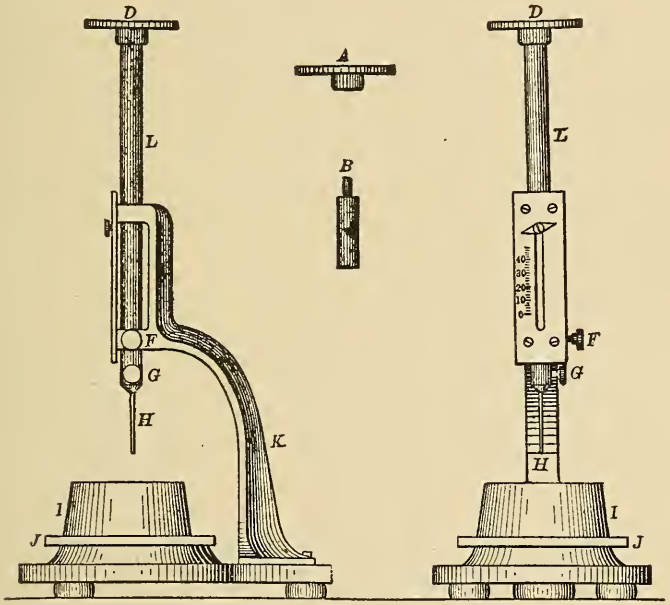


FIG. 2.—VICAT NEEDLE.

(*L*), with the cap (*A*) at one end, and at the other the cylinder (*B*), 1 m. (0.39 in.) in diameter, the cap, rod and cylinder weighing 300 gr. (10.58 oz.). The rod, which can be held in any desired position by a screw (*F*), carries an indicator, which moves over a scale (graduated to centimeters) attached to the frame (*K*). The paste is held by a conical hard-rubber ring (*I*), 7 cm. (2.76 in.) in diameter at the base, 4 cm. (1.57 in.) high, resting on a glass plate (*J*), about 10 cm. (3.94 in.) square.

18. In making the determination, the same quantity of cement as will be subsequently used for each batch in making the briquettes [but

Method.

not less than 500 gr. (17.16 oz.)] is kneaded into a paste, as described in paragraph 38, and quickly formed into a ball with the hands, completing the operation by tossing it six times from one hand to the other, maintained 6 in. apart; the ball is then pressed into the rubber ring, through the larger opening, smoothed off and placed (on its large end) on a glass plate and the smaller end smoothed off with a trowel; the paste, confined in the ring, resting on the plate, is placed under the rod bearing the cylinder, which is brought in contact with the surface and quickly released.

19. The paste is of normal consistency when the cylinder penetrates to a point in the mass 10 mm. (0.39 in.) below the top of the ring. Great care must be taken to fill the ring exactly to the top.

20. The trial pastes are made with varying percentages of water until the correct consistency is obtained.

Note. The Committee on Standard Specifications for Cement inserts the following table for temporary use, to be replaced by one to be devised by the Committee of the American Society of Civil Engineers:

PERCENTAGE OF WATER FOR STANDARD MIXTURES.

Neat	1-1	1-2	1-3	1-4	1-5	Neat	1-1	1-2	1-3	1-4	1-5
18	12.0	10.0	9.0	8.4	8.0	33	17.0	13.3	11.5	10.4	9.6
19	12.3	10.2	9.2	8.5	8.1	34	17.3	13.6	11.7	10.5	9.7
20	12.7	10.4	9.3	8.7	8.2	35	17.7	13.8	11.8	10.7	9.9
21	13.0	10.7	9.5	8.8	8.3	36	18.0	14.0	12.0	10.8	10.0
22	13.3	10.9	9.7	8.9	8.4	37	18.3	14.2	12.2	10.9	10.1
23	13.7	11.1	9.8	9.1	8.5	38	18.7	14.4	12.3	11.1	10.2
24	14.0	11.3	10.0	9.2	8.6	39	19.0	14.7	12.5	11.2	10.3
25	14.3	11.6	10.2	9.3	8.8	40	19.3	14.9	12.7	11.3	10.4
26	14.7	11.8	10.3	9.5	8.9	41	19.7	15.1	12.8	11.5	10.5
27	15.0	12.0	10.5	9.6	9.0	42	20.0	15.3	13.0	11.6	10.6
28	15.3	12.2	10.7	9.7	9.1	43	20.3	15.6	13.2	11.7	10.7
29	15.7	12.5	10.8	9.9	9.2	44	20.7	15.8	13.3	11.9	10.8
30	16.0	12.7	11.0	10 0	9.3	45	21.0	16.0	13.5	12.0	11.0
31	16.3	12.9	11.2	10.1	9.4	46	21.3	16.1	13.7	12.1	11.1
32	16.7	13.1	11.3	10 3	9 5	.....	.....	.....	.....	.....	.....

	1 to 1	1 to 2	1 to 3	1 to 4	1 to 5
Cement.....	500	333	250	200	167
Sand.....	500	667	750	800	833

TIME OF SETTING.

21. For this purpose the Vicat Needle, which has already been described in paragraph 17, should be used.

22. In making the test, a paste of normal consistency is molded and placed under the rod (*L*), Fig. 2, as described in paragraph 18; this rod, bearing the cap (*D*) at one end and the needle (*H*), 1 mm.

(0.039 in.) in diameter, at the other, weighing 300 gr. (10.58 oz.). The needle is then carefully brought in contact with the surface of the paste and quickly released.

23. The setting is said to have commenced when the needle ceases to pass a point 5 mm. (0.20 in.) above the upper surface of the glass plate, and is said to have terminated the moment the needle does not sink visibly into the mass.

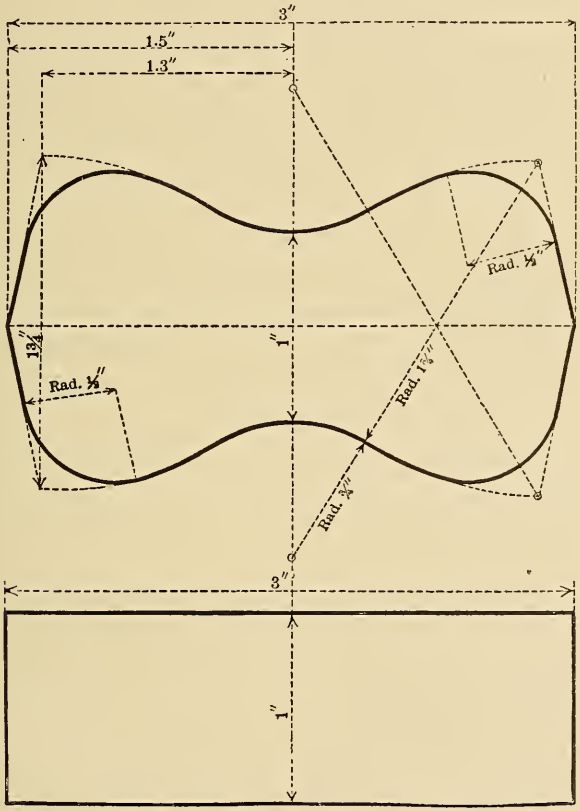


FIG. 3.—DETAILS FOR BRIQUETTE.

24. The test pieces should be stored in moist air during the test; this is accomplished by placing them on a rack over water contained in a pan and covered with a damp cloth, the cloth to be kept away from them by means of a wire screen; or they may be stored in a moist box or closet.

25. Care should be taken to keep the needle clean, as the collection of cement on the sides of the needle retards the penetration, while

Method.

cement on the point reduces the area and tends to increase the penetration.

26. The determination of the time of setting is only approximate, being materially affected by the temperature of the mixing water, the temperature and humidity of the air during the test, the percentage of water used, and the amount of molding the paste receives.

STANDARD SAND.

Standard Sand.

27. For the present, the Committee recommends the natural sand from Ottawa, Ill., screened to pass a sieve having 20 meshes per linear inch and retained on a sieve having 30 meshes per linear inch; the wires to have diameters of 0.0165 and 0.0112 in., respectively, *i. e.*, half the width of the opening in each case. Sand having passed the No. 20 sieve shall be considered standard when not more than 1 per cent. passes a No. 30 sieve after one minute continuous sifting of a 500-gr. sample.

28. The Sandusky Portland Cement Company of Sandusky, Ohio, has agreed to undertake the preparation of this sand and to furnish it at a price only sufficient to cover the actual cost of preparation.

FORM OF BRIQUETTE.

Form of Briquette.

29. While the form of the briquette recommended by a former Committee of the Society is not wholly satisfactory, this Committee is not prepared to suggest any change, other than rounding off the corners by curves of ½-in. radius, Fig. 3.

MOLDS.

Molds.

30. The molds should be made of brass, bronze or some equally non-corrodible material, having sufficient metal in the sides to prevent spreading during molding.

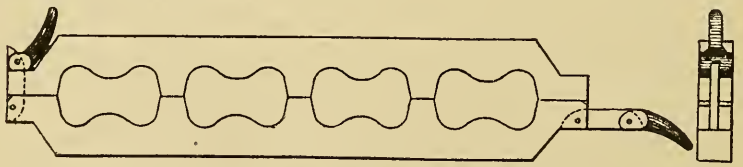


FIG. 4.—DETAILS FOR GANG MOLD.

31. Gang molds, which permit molding a number of briquettes at one time, are preferred by many to single molds; since the greater quantity of mortar that can be mixed tends to produce a greater uniformity in the results. The type shown in Fig. 4 is recommended.

32. The molds should be wiped with an oily cloth before using.

MIXING.

33. All proportions should be stated by weight; the quantity of water to be used should be stated as a percentage of the dry material. Mixing.

34. The metric system is recommended because of the convenient relation of the gram and the cubic centimeter.

35. The temperature of the room and the mixing water should be as near 21° C. (70° F.) as it is practicable to maintain it.

36. The sand and cement should be thoroughly mixed dry. The mixing should be done on some non-absorbing surface, preferably plate glass. If the mixing must be done on an absorbing surface it should be thoroughly dampened prior to use.

37. The quantity of material to be mixed at one time depends on the number of test pieces to be made; about 1,000 gr. (35.28 oz.) makes a convenient quantity to mix, especially by hand methods.

38. The material is weighed and placed on the mixing table, and a crater formed in the center, into which the proper percentage of clean water is poured; the material on the outer edge is turned into the crater by the aid of a trowel. As soon as the water has been absorbed, which should not require more than one minute, the operation is completed by vigorously kneading with the hands for an additional 1½ minutes, the process being similar to that used in kneading dough. A sandglass affords a convenient guide for the time of kneading. During the operation of mixing the hands should be protected by gloves, preferably of rubber. Method.

MOLDING.

39. Having worked the paste or mortar to the proper consistency, it is at once placed in the molds by hand.

40. The molds should be filled at once, the material pressed in firmly with the fingers and smoothed off with a trowel without ramming; the material should be heaped up on the upper surface of the mold, and, in smoothing off, the trowel should be drawn over the mold in such a manner as to exert a moderate pressure on the excess material. The mold should be turned over and the operation repeated. Method.

41. A check upon the uniformity of the mixing and molding is afforded by weighing the briquettes just prior to immersion, or upon removal from the moist closet. Briquettes which vary in weight more than 3 per cent. from the average should not be tested.

STORAGE OF THE TEST PIECES.

42. During the first 24 hours after molding, the test pieces should be kept in moist air to prevent them from drying out.

Method.

43. A moist closet or chamber is so easily devised that the use of the damp cloth should be abandoned if possible. Covering the test pieces with a damp cloth is objectionable, as commonly used, because the cloth may dry out unequally, and in consequence the test pieces are not all maintained under the same condition. Where a moist closet is not available, a cloth may be used and kept uniformly wet by immersing the ends in water. It should be kept from direct contact with the test pieces by means of a wire screen or some similar arrangement.

44. A moist closet consists of a soapstone or slate box, or a metal-lined wooden box—the metal lining being covered with felt and this felt kept wet. The bottom of the box is so constructed as to hold water, and the sides are provided with cleats for holding glass shelves on which to place the briquettes. Care should be taken to keep the air in the closet uniformly moist.

45. After 24 hours in moist air, the test pieces for longer periods of time should be immersed in water maintained as near 21° C. (70° F.) as practicable; they may be stored in tanks or pans, which should be of non-corrodible material.

TENSILE STRENGTH.

Tensile Strength.

46. The tests may be made on any standard machine. A solid metal clip, as shown in Fig. 5, is recommended. This clip is to be used without cushioning at the points of contact with the test specimen. The bearing at each point of contact should be ¼-in. wide, and the distance between the centers of contact on the same clip should be 1¼ in.

47. Test pieces should be broken as soon as they are removed from the water. Care should be observed in centering the briquettes in the testing machine, as cross-strains, produced by improper centering, tend to lower the breaking strength. The load should not be applied too suddenly, as it may produce vibration, the shock from which often breaks the briquette before the ultimate strength is reached. Care must be taken that the clips and the sides of the briquette be clean and free from grains of sand or dirt which would prevent a good bearing. The load should be applied at the rate of 600 lbs. per minute. The average of the briquettes of each sample tested should be taken as the test, excluding any results which are manifestly faulty.

CONSTANCY OF VOLUME.

Method.

48. Tests for constancy of volume are divided into two classes: (1) Normal tests, or those made in either air or water maintained at

about 21° C. (70° F.), and (2) accelerated tests, or those made in air, steam or water at a temperature of 45° C. (115° F.) and upward. The test pieces should be allowed to remain 24 hours in moist air before immersion in water or steam, or preservation in air.

49. For these tests, pats about 7½ cm. (2.95 in.) in diameter, 1¼ cm. (0.49 in.) thick at the center, and tapering to a thin edge, should

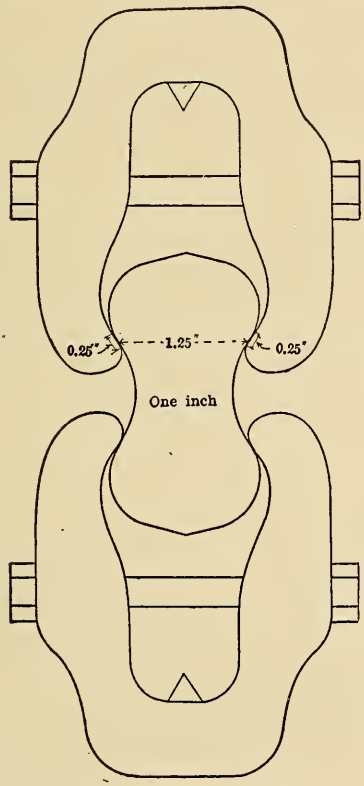


FIG. 5.—FORM OF CLIP.

be made, upon a clean glass plate [about 10 cm. (3.94 in.) square], from cement paste of normal consistency.

50. A pat is immersed in water maintained as near 21° C. (70° F.) as possible for 28 days, and observed at intervals. A similar pat is maintained in air at ordinary temperature and observed at intervals. Normal Test.

51. A pat is exposed in any convenient way in an atmosphere of steam, above boiling water, in a loosely closed vessel. Accelerated Test.

52. To pass these tests satisfactorily, the pats should remain firm and hard, and show no signs of cracking, distortion or disintegration.

53. Should the pat leave the plate, distortion may be detected best with a straight-edge applied to the surface which was in contact with the plate.

*SPECIFICATIONS FOR STONE MASONRY.

RECOMMENDED STANDARD SPECIFICATIONS.

SPECIFICATIONS FOR STONE MASONRY.

GENERAL.

Standard Specifications.

1. The classification of Masonry and the requirements for cement and concrete shall be those adopted as the recommended practice of the American Railway Engineering and Maintenance of Way Association.

Engineer Defined.

2. Where the term "Engineer" is used in these specifications, it refers to the engineer actually in charge of the work.

GENERAL REQUIREMENTS.

Stone.

3. Stone shall be of the kinds specially designated and shall be hard and durable, free from seams or other imperfections, of approved quality and shape, and in no case shall have less bed than rise. When liable to be affected by freezing, no unseasoned stone shall be laid.

Dressing.

4. Dressing shall be the best of the kind specified.

5. Beds and joints or builds shall be square with each other, and dressed true and out of wind. Hollow beds shall not be allowed.

6. Stone shall be dressed for laying on natural beds.

7. Marginal drafts shall be neat and accurate.

8. Pitching shall be done to true lines and exact batter.

Mortar.

9. Mortar shall be mixed in a suitable box, and kept clean and free from foreign matter. Sand and cement shall be mixed dry and in small batches in proportions as directed by the engineer; water shall then be added; and the whole mixed until the mass of mortar is thoroughly homogeneous and leaves the hoe clean when drawn from it. Mechanical mixing, to produce the same results, may be permitted. Mortar shall not be retempered after it has begun to set.

* Adopted, Vol. 7, 1906, pp. 581-587, 602-604, 606-622. Revised and adopted preliminarily at 1907 convention, Vol. 8, p. 634, subject to formal adoption at 1908 convention.

Laying.

10. The arrangement of courses and bond shall be as indicated on the drawings, or as directed by the engineer. Stone shall be laid to exact lines and levels, to give the required bond and thickness of mortar in beds and joints.

11. Stone shall be cleansed and dampened before laying.

12. Stone shall be well bonded, laid on its natural bed and solidly settled into place in a full bed of mortar.

13. Stone shall not be dropped or slid over the wall, but shall be placed without jarring stone already laid.

14. Heavy hammering shall not be allowed on the wall after a course is laid.

15. Stone becoming loose after the mortar is set shall be relaid with fresh mortar.

16. Stone shall not be laid in freezing weather, unless directed by the engineer. If laid, it shall be freed from ice, snow or frost by warming; the sand and water used in the mortar shall be heated.

17. With precaution, a brine may be substituted for the heating of the mortar. The brine shall consist of one pound of salt to eighteen gallons of water, when the temperature is 32 degrees Fahrenheit; for every degree of temperature below 32 degrees Fahrenheit, one ounce of salt shall be added.

Pointing.

18. Before the mortar has set in beds and joints, it shall be removed to a depth of not less than one (1) in. Pointing shall not be done until the wall is complete and mortar set; nor when frost is in the stone.

19. Mortar for pointing shall consist of equal parts of sand, sieved to meet the requirements, and Portland cement. In pointing, the joints shall be wet, and filled with mortar, pounded in with a "set-in" or calking tool and finished with a beading tool the width of a joint, used with a straight-edge.

BRIDGE AND RETAINING WALL MASONRY.

ASHLAR STONE.

Bridge and Retaining Wall Masonry. Ashlar Stone. Dressing.

20. The stone shall be large and well proportioned. Courses shall not be less than fourteen (14) in. or more than thirty (30) in. thick, thickness of courses to diminish regularly from bottom to top.

21. Beds and joints or builds of face stone shall be fine-pointed, so that the mortar layer shall not be more than one-half (½) in. thick when the stone is laid.

22. Joints in face stone shall be full to the square for a depth equal to at least one-half the height of the course, but in no case less than twelve (12) in.

Face or Surface.

23. Exposed surfaces of the face stone shall be rock-faced, and edges pitched to true lines and exact batter; the face shall not project more than three (3) in. beyond the pitch line.

24. Chisel drafts one and one-half (1½) in. wide shall be cut at exterior corners.

25. Holes for stone hooks shall not be permitted to show in exposed surfaces. Stone shall be handled with clamps, keys, lewis or dowels.

Stretchers.

26. Stretchers shall not be less than four (4) ft. long and have at least one and a quarter times as much bed as thickness of course.

Headers.

27. Headers shall not be less than four (4) ft. long, shall occupy one-fifth of face of wall, shall not be less than eighteen (18) in. wide in face, and, where the course is more than eighteen (18) in. high, width of face shall not be less than height of course.

28. Headers shall hold in heart of wall the same size shown in face, so arranged that a header in a superior course shall not be laid over a joint, and a joint shall not occur over a header; the same disposition shall occur in back of wall.

29. Headers in face and back of wall shall interlock when thickness of wall will admit.

30. Where the wall is three (3) ft. thick or less, the face stone shall pass entirely through. Backing shall not be allowed.

Backing.

*31-a. Backing shall be large, well-shaped stone, roughly bedded and jointed; bed joints shall not exceed one (1) in. At least one-half of the backing stone shall be of same size and character as the face stone and with parallel ends. The vertical joints in back of wall shall not exceed two (2) in. The interior vertical joints shall not exceed six (6) in. Voids shall be thoroughly filled with *concrete. spalls, fully bedded in cement mortar.*

*31-b. Backing shall be of *concrete. headers and stretchers, as specified in paragraphs 26 and 27, and heart of wall filled with concrete.*

32. Where the wall will not admit of such arrangement, stone not less than four (4) ft. long shall be placed transversely in heart of wall to bond the opposite sides.

* Paragraphs 31-a and 31-b are so arranged that either may be eliminated according to requirements. Optional clauses printed in italics.

33. Where stone is backed with two courses, neither course shall be less than eight (8) in. thick.

34. Bond of stone in face, back and heart of wall shall not be less than twelve (12) in. Backing shall be laid to break joints with the face stone and with one another. Bond.

35. Coping stone shall be full size throughout, of dimensions indicated on the drawings. Coping.

36. Beds, joints and top shall be fine-pointed.

37. Location of joints shall be determined by the position of the bed plates, and be indicated on the drawings.

38. Where required, coping stone, stone in the wings of abutments, and stone on piers shall be secured together with iron cramps or dowels, in the position indicated on the drawings. Locks.

BRIDGE AND RETAINING WALL MASONRY.

RUBBLE STONE.

39. The stone shall be roughly squared, and laid in irregular courses. Beds shall be parallel, roughly dressed, and the stone laid horizontal to the wall. Face joints shall not be more than one (1) in. thick. Bottom stone shall be large, selected flat stone.

40. The wall shall be compactly laid, having at least one-fifth the surface of back and face headers arranged to interlock, having all voids in the heart of the wall thoroughly filled with *concrete.* *suitable stones and spalls, fully bedded in cement mortar.*

ARCH MASONRY.

ASHLAR STONE.

41. Voussoirs shall be full size throughout and dressed true to templet, and shall have bond not less than thickness of stone. Arch Masonry, Ashlar Stone.

42. Joints of voussoirs and intrados shall be fine-pointed. Mortar joints shall not exceed three-eighths (3/8) in. Dressing.

43. Exposed surfaces of the ring stone shall be *smooth.* *rock-faced, with a marginal draft.* Face or Surface.

44. Number of courses and depth of voussoirs shall be indicated on the drawings.

45. Voussoirs shall be placed in the order indicated on the drawings.

Backing.

46. Backing shall consist of *concrete.*
large stone, shaped to fit the arch bonded to the spandrel and laid in full bed of mortar.

47. Where waterproofing is required, a thin coat of mortar or grout shall be applied evenly for a finishing coat, upon which shall be placed a covering of approved waterproofing material.

48. Centers shall not be struck until directed by the engineer.

Bench Walls, Piers, Spandrels, etc.

49. Bench walls, piers, spandrels, parapets, wing walls and copings shall be built under the specifications for Bridge and Retaining Wall Masonry, Ashlar Stone.

ARCH MASONRY.

RUBBLE STONE.

Arch Masonry, Rubble Stone. Dressing.

50. Voussoirs shall be full size throughout, and shall have bond not less than thickness of voussoirs.

51. Beds shall be roughly dressed to bring them to radial planes.

52. Mortar joints shall not exceed one (1) in.

Face or Surface.

53. Exposed surfaces of the ring stone shall be rock-faced, and edges pitched to true lines.

54. Voussoirs shall be placed in the order indicated on the drawings.

Backing.

55. Backing shall consist of *concrete.*
large stone, shaped to fit the arch, bonded to the spandrel, and laid in full bed of mortar.

56. Where waterproofing is required, a thin coat of mortar or grout shall be applied evenly for a finishing coat, upon which shall be placed a covering of approved waterproofing material.

57. Centers shall not be struck until directed by the engineer.

Bench Walls, Piers, Spandrels, etc.

58. Bench walls, piers, spandrels, parapets, wing walls and copings shall be built under the specifications for Bridge and Retaining Wall Masonry, Rubble Stone.

CULVERT MASONRY.

Culvert Masonry.

59. Culvert Masonry shall be laid in cement mortar. Character of stone and quality of work shall be the same as specified for Bridge and Retaining Wall Masonry, Rubble Stone.

Side Walls.

60. One-half the top stone of the side walls shall extend entirely across the wall.

Cover Stones.

61. Covering stone shall be sound and strong, at least twelve (12) in. thick, or as indicated on the drawings. They shall be roughly dressed to make close joints with each other, and lap their entire width at least twelve (12) in. over the side walls. They shall be doubled under high embankments, as indicated on the drawings.

End Walls, Coping.

62. End walls shall be covered with suitable coping, as indicated on the drawings.

DRY MASONRY.

Dry Masonry.

63. Dry Masonry shall include dry retaining walls and slope walls.

Retaining Walls.

64. Retaining Walls of Dry Masonry shall include all walls in which rubble stone laid without mortar is used for retaining embankments or for similar purposes.

Dressing.

65. Flat stone at least twice as wide as thick shall be used. Beds and joints shall be roughly dressed square to each other and to face of stone.

66. Joints shall not exceed three-quarters (¾) in.

Disposition of Stone.

67. Stone of different sizes shall be evenly distributed over entire face of wall, generally keeping the largest stone in lower part of wall.

68. The work shall be well bonded and present a reasonably true and smooth surface, free from holes or projections.

Slope Walls.

69. Slope walls shall be built of such thickness and slope as directed by the engineer. Stone shall not be used in this construction which does not reach entirely through the wall. Stone shall be placed at right angles to the slopes. The wall shall be built simultaneously with the embankment which it is to protect.

COMMITTEE NO. IX.

SIGNS, FENCES, CROSSINGS AND CATTLE-GUARDS.

* FENCES.

DEFINITIONS.

FENCE.—A line of posts and rails or wires, or of boards and pickets; a wall, hedge, ditch, trench, bank or anything that serves to guard against unrestricted ingress and egress.

FENCE POST.—An upright piece of timber, metal or other material used as a support for the attachment of the longitudinal members of the fence.

END POST.—A post at the end of a line or section of fence.

INTERMEDIATE POST.—A post used between end posts.

GATE POST.—A post to which a gate is hung or latched.

ANCHOR POST.—A fence post fixed or fastened in position by some contrivance.

CLEAT.—A piece of wood or metal fastened transversely to the sides of a post below the ground line to give it greater stability.

BRACE.—A piece of timber or metal, in compression, placed diagonally or horizontally between any post and the next post to it.

STAY.—A form of timber, metal or other material, whether vertical or inclined, serving the purpose of keeping the longitudinal wires the proper distance apart and stiffening the fence.

STAY WIRE.—A stay formed of wire.

FENCE STAPLE.—A metal device, in the shape of the letter "U" with ends sharpened, for fastening the longitudinal members of the fence to the post.

PANEL.—A section of fence between adjoining posts.

BRACE PANEL.—A panel in which a brace, or tie, or both, are introduced.

TOP WIRE.—The highest longitudinal wire of a fence.

INTERMEDIATE WIRE.—A longitudinal wire located between top and bottom wires.

* Adopted, Vol. 5, 1904, pp. 381, 382, 390, 446-451; Vol. 6, 1905, pp. 781, 782; Vol. 7, 1906, pp. 458, 479.

Bottom Wire.—The lowest longitudinal wire of a fence.

Tie Wire.—A wire in tension between any two posts used to assist the brace.

Gate.—A movable barrier consisting of a frame or structure of wood, metal or other material for closing a passage or opening in a fence.

Gate Latch.—A device for fastening the free end of a gate to a gate post.

Gate Frame.—The sustaining parts of a gate, fitted and framed together, to which the other longitudinal and vertical members are attached.

Gate Brace.—A piece of wood or metal serving the purpose of stiffening the frame of a gate.

Gate Hinge.—A device for attaching a gate to a post and upon which the gate swings.

Fence Anchor.—A contrivance of wood, metal or other material designed to prevent a fence post from being raised or moved.

*SURFACE CATTLE-GUARDS.

DEFINITIONS.

Cattle-Guard.—A barrier used at the intersection of a wing-fence with a railroad track to prevent the passage of live stock along the track.

Apron.—The flaring panel of fence set parallel with the track between the cattle-guard and the wing-fence.

Wing-Fence.—The line of fence making connection between the apron of the cattle-guard and the right-of-way or line fence.

Section.—A group of slats or strips which go to make up a surface cattle-guard.

Filler.—A piece of timber, metal, or other material used between the slats composing a section of a surface cattle-guard to space and stiffen them.

Slat.—Strips of wood or metal to be used singly or in groups to make up sections of a surface cattle-guard.

†FENCES.

RECOMMENDED PRACTICE.

(1) The use of smooth wire in preference to barbed wire for railroad fences is recommended.

* Adopted, Vol. 5, 1904, pp. 386, 390, 458, 459.
† Adopted, Vol. 5, 1904, pp. 388, 455-457; Vol. 6, 1905, pp. 781, 782.

(2) The use of heavier smooth wire than has generally been adopted is recommended.

(3) The use of a heavy smooth wire, or a plank at top of barbed wire fence, is recommended.

* CATTLE-GUARDS.

RECOMMENDED PRACTICE.

The use of the surface in preference to the pit cattle-guard is recommended.

† GENERAL REQUIREMENTS FOR SURFACE CATTLE-GUARDS.

RECOMMENDED PRINCIPLES OF PRACTICE.

The use of a surface cattle-guard is recommended and that it be designed as nearly as possible to meet the following requirements:

(1) It should be so constructed as to overcome the objectionable features of the pit guard, particularly so far as endangering trains is concerned. Projecting surfaces which would be liable to be caught by dragging brake or other rigging should be avoided.

(2) The cattle-guard should be of such construction as not to endanger employés who pass over it in the discharge of their duties.

(3) It should be effective as to all kinds of live stock, and at the same time have no parts which would catch and hold stock that might endeavor to pass.

(4) It should be reasonable in first cost, durable and easily applied and removed, so as to allow repairs of track at minimum expense.

(5) It should not rattle during the passage of trains.

‡ SPECIFICATIONS FOR STANDARD RIGHT-OF-WAY FENCES, BUILT WITH WOODEN POSTS.

RECOMMENDED STANDARD SPECIFICATIONS.

Classes.

1. Three classes of smooth wire fences may be used, the top wire of each to be 4 ft. 6 in. above the ground.

First-class Fence.

2. A first-class fence shall consist of nine longitudinal, smooth, coiled, galvanized steel wires; the top and bottom wires shall be No. 7 gage; intermediate and stay wires shall be No. 9 gage.

The spacing of the longitudinal wires shall be, commencing at the

* Adopted, Vol. 5, 1904, pp. 388, 460, 461.
† Adopted, Vol. 5, 1904, pp. 387, 390, 459, 461, 462.
‡ Adopted, Vol. 7, 1906, pp. 451-454, 478.

bottom: 3, 4, 5, 6, 7, 8, 9 and 9 in. The bottom wire shall be 3 in. above the ground, and the stay wires shall be spaced 12 in. apart.

Second-class Fence.

3. A second-class fence shall consist of seven longitudinal, smooth, coiled, galvanized steel wires; the longitudinal wires and stay wires shall be No. 9 gage.

The spacing of the longitudinal wires shall be, commencing at the bottom, 5, 6½, 7½, 9, 10 and 10 in. The bottom wire shall be 6 in. above the ground, and the stay wires shall be spaced 22 in. apart.

Third-class Fence.

4. † A third-class fence shall consist of four longitudinal, smooth, coiled galvanized steel wires; the longitudinal and stay wires shall be No. 9 gage.

The longitudinal wires shall be spaced 14 in. apart; the bottom wires shall be 12 in. above the ground, and the stay wires shall be spaced 22 in. apart.

MATERIAL.

Posts.

5. Posts shall be of ..... They shall be straight and free from rot or other defects. Split or sawn posts may be used in localities where round posts are not economically available; their dimensions shall be at least equal to those hereinafter specified for round posts.

End Posts.

6. End or gate posts and intermediate bracing panel posts shall be 9 ft. long and 8 in. in diameter at the small end, or 8x8 in. if sawn.

Intermediate Posts.

7. Intermediate posts shall be 8 ft. long and not less than 4 in. in diameter at the small end.

Braces.

8. Braces for end posts, gate posts and intermediate brace panels shall be 4x4 in. common lumber, 12 ft. long, free from large knots, splits or rot.

Wire.

9. Woven wire fences shall be constructed of steel galvanized wire. Longitudinal wires shall be coiled.

The elastic limit of all wire shall be at least 1,500 lbs. for No. 9 gage wire, and 2,000 lbs. for No. 7 gage wire.

The ultimate tensile strength shall be at least 1,800 lbs. for No. 9 gage wire, and 2,500 lbs. for No. 7 gage wire. It must stand, without sign of fracture, winding tight around wire of the same size.

Stay Wires.

10. Stay wires shall be straight and of No. 9 gage.

Locks.

11. Locks or fastenings at the intersection of the longitudinal and stay wires shall be of such design as will prevent them from slipping either longitudinally or vertically.

† When desirable, 1x2-in. wooden stays, stood on the ground and interlaced between the longitudinal wires, may be used, spaced 6 to 8 ft. apart, in place of or in addition to the stay wires.

Staples.

12. Staples used in posts shall be 1 in. long for hard wood, and 1½ in. long for soft wood, and be made of No. 9 galvanized steel wire.

Galvanizing.

13. Galvanizing shall consist of an even coating of zinc, which shall withstand one-minute immersion tests in a solution of commercial sulphate of copper crystals and water, the specific gravity of which shall be 1.185 and whose temperature shall be from 60 to 70 degrees Fahrenheit. Immediately after each immersion the sample shall be washed in water and wiped dry. If the zinc is removed, or a copper-colored deposit is formed after the fourth immersion, the lot of material from which the sample is taken shall be rejected.

Manufacture.

14. The fence shall be so manufactured as not to remove the galvanizing nor impair the tensile strength of the wire.

ERECTION.

End Posts.

15. End posts shall be set vertical, at least 4 ft. in the ground, thoroughly tamped, braced and anchored.

Gate Posts.

16. Gate posts shall be set vertical and braced in a similar manner to the end posts.

Intermediate Posts.

17. Intermediate posts shall be set at least 3 ft. in the ground, and from 16½ to 33 ft. apart, depending upon the nature of the ground and the service required. Holes of full depth shall be provided for all end and gate posts, even if blasting must be resorted to. For intermediate posts, where rock is encountered, not more than two adjacent posts shall be set on sills 6x6 in. by 4 ft. long, braced on both sides by 2x6 in. braces, 3 ft. long. Holes shall be provided for all other posts.

All posts shall be set with the large end down.

All posts shall be set in perfect line on the side on which the wire is to be strung. After the fence is erected, the top of the posts shall be sawed off with a one-fourth pitch, the high side being next to the wire and 4 in. above it.

Anchoring.

18. End and gate posts shall be anchored by gaining and spiking two cleats to the sides of the posts, at right angles to the line of fence, one at the bottom and the other just below the surface of the ground. The cleat near the ground surface shall be put on the side of the post next the fence and the bottom cleat shall be put on the opposite side.

Intermediate posts set in depressions of the ground shall be anchored by gaining two cleats into the side near the bottom of the post, same to be properly spiked.

Cleats. 19. Cleats shall be 2x6 in. by 3 ft. long, of common lumber.

Bracing. 20. End. corner and gate posts shall be braced by a piece of 4x4 in. common lumber, gained into the end corner or gate post, about 12 in. from the top, and into the next intermediate post, about 12 in. from the ground, and be securely spiked. A cable made of a double strand of No. 9 soft galvanized wire looped around the end post at the ground line, and around the next intermediate post, about 12 in. below the top, shall be put on and twisted until the top of the next intermediate post is thrown back at least 2 in.

Stretching. 21. Longitudinal wires shall be stretched uniformly tight, and be parallel; stays shall be straight and vertical and be uniformly spaced. Wires shall be placed on the side of the post away from the track, except on curves, where they shall be so placed that the pull of the wires is against the post.

Stapling. 22. Staples shall be set diagonally with the grain of the wood, and be driven home tight. The top wire shall be double stapled.

Splicing. 23. Approved bolt clamp splices or a wire splice made as follows may be used: In making wire splices the ends of the wires shall be carried 3 in. past the splicing tools and wrapped around both wires backward toward the tool for at least five turns, and after the tool is removed the space occupied by it shall be closed by pulling the ends together.

*GALVANIZED WIRE FENCING.

RECOMMENDED PRINCIPLES OF PRACTICE.

The rapid deterioration of modern woven galvanized fence wire is caused by the coating of zinc being too thin and of an uneven thickness. To procure better protection to the wire and a longer lived fence it is necessary to secure an increased uniform thickness of the zinc coating on the wire, and to insure that the galvanizing is intact after the wire has gone through the fence-weaving machines it is recommended that a second coat of zinc be applied to the fence after it is manufactured.

†TENSILE STRENGTH OF FENCE WIRE.

RECOMMENDED PRINCIPLES OF PRACTICE.

It is recommended that hard wire, the ultimate tensile strength of which for No. 9 gage is from 1,800 to 2,200 lbs., should be used for

* Adopted, Vol. 7, 1906, pp. 456, 479.
† Adopted, Vol. 7, 1906, pp. 458, 479.

longitudinal wire; and that the verticals and fastenings be as near the above in ultimate tensile strength as the action of the various fence weaving or erecting machines will admit without injuring the wire.

*GATES FOR RIGHT-OF-WAY FENCES.

RECOMMENDED PRINCIPLES OF PRACTICE

The swing board gate is recommended where traffic is very light, and the hinged board or hinged tubular wire gate, whichever is cheapest, at other points.

* Adopted, Vol. 8, 1907, pp. 528, 533.

COMMITTEE NO. X.

SIGNALING AND INTERLOCKING.

*SIGNALING AND INTERLOCKING.

DEFINITIONS.

Definitions from Standard Code of The American Railway Association.

BLOCK.—A length of track of defined limits, the use of which by trains is controlled by block signals.

BLOCK STATION.—A place from which block signals are operated.

BLOCK SIGNAL.—A fixed signal controlling the use of a block.

HOME BLOCK SIGNAL.—A fixed signal at the entrance of a block, to control trains in entering and using said block.

DISTANT BLOCK SIGNAL.—A fixed signal used in connection with a home block signal, or a home and advance block signal to regulate the approach thereto.

ADVANCE BLOCK SIGNAL.—A fixed signal used in connection with home block signal to divide the block in advance.

BLOCK SYSTEM.—A series of consecutive blocks.

TELEGRAPH BLOCK SYSTEM.—A block system in which the signals are operated manually, upon information by telegraph.

CONTROLLED MANUAL BLOCK SYSTEM.—A block system in which the signals are operated manually, and so constructed as to require the co-operation of the signalman at each end of the block, respectively, to display a clear signal.

AUTOMATIC BLOCK SYSTEM.—A block system, in which the signals are operated by electric, pneumatic, or other agency actuated by train or by certain conditions affecting the use of a block.

MAST.—The upright to which the signals are directly attached.

* Adopted, Vol. 7, 1906, pp. 482, 522-524.

ABSOLUTE BLOCK SYSTEM.—One in which only one train at a time is permitted to occupy the block.

ARM CASTING.—That part of the arm supported by the signal mast, which, by rotation on its axis of support, gives the night signal indications.

ARM SWEEP.—The segment of a circle defining the *limits* of movement of the arm.

ARM.—A movable arm pivoted to the signal mast, the positions of which give the indications.

BLADE.—That part of the arm which, by its form and position, gives the day signal indications.

BRACKET POST.—An arrangement of main post with cross-beam, upon which is placed one or two masts for carrying the signal arms, the arrangement of masts determining which track or tracks the signals govern.

CHAIN WHEEL.—A device used for changing the direction of a wire line.

COMPENSATOR.—A device placed in a pipe or wire line for automatically maintaining a constant length of line under changes of temperature.

CRANK.—A device used for changing the direction of a pipe line.

CRANK STAND.—A frame in which cranks are supported.

CROSS LOCKING.—A variable shaped block or bar running crosswise of the interlocking machine, actuated by the movements of the locking dog, and by means of which connection is effected between the levers.

DETECTOR BAR.—A bar placed at a switch alongside of and normally below the top of rail, operated in connection with a facing point lock, derailing device or crossing switch, or so that its operation, and consequently that of the lock, will be prevented by the presence of any of the wheels of the train.

ELECTRIC SLOT.—An appliance for automatically disengaging the signal arm connection from its actuating lever, returning signal arm to "stop."

FOUNDATION.—A fixed support, usually set in the ground, for carriers, cranks, compensators, wheels, signals and other like devices.

INTERLOCKING MACHINE.—The primary operating or controlling mechanism of an interlocking plant, placed in the interlocking station, and in which the interlocking feature is effected.

INTERLOCKING PLANT.—An arrangement of switch, lock and signal appliances so interconnected or interlocked that one movement must succeed another in a predetermined order.

INTERLOCKING SIGNALS.—The fixed signals of an interlocking plant.

INTERLOCKING STATION.—A place from which an interlocking plant is operated.

JAW.—A device attached to pipe line for connecting same with machine, crank, compensator, or any other device designed for pipe operation.

LEADOUT.—A combination of cranks, wheels, rocking shafts, pipes and wire, etc., inside and outside of interlocking station by which connections are made between machine and pipe runs.

LEVER.—That part of an interlocking machine whose movement effects the operation of its function.

LOCKING.—A combination of locking dogs and cross-locking or locking dogs and tappets by means of which interconnection is effected between the levers and the order of movement determined.

LOCKING BAR.—A bar running lengthwise in the interlocking machine to which the locking dogs are attached.

LOCKING DOG.—A variously shaped block attached to locking bar and through which the interlocking is accomplished.

PERMISSIVE BLOCK SYSTEM.—One in which two or more trains may occupy a block at the same time.

PIPE CARRIER.—A frame with roller support for the pipe line.

PIPE RUN.—An assemblage of pipe lines of an interlocking plant, with their carriers and foundations, in a common course.

ROCKING SHAFT.—A rotating shaft with arms, used for changing the line of motion from one plane to another, perpendicular to the axis of the shaft; also used at slip switches for operating several detector bars and locks.

ROUTE.—A course or way taken by a train in passing from one point to another, especially a customary or predetermined course, or any one of several possible combinations of turnouts or crossovers by which a train may travel between two places.

SEMAPHORE SIGNAL.—A device consisting of a movable arm attached to a mast, the indications being given by the position of the arm.

SCREW JAW.—A threaded jaw used for the purpose of adjustment.

SPECTACLE.—See "Arm Casting."

TAPPET.—a. (In machine with vertical locking.) A bar operated directly or indirectly by the lever or lever latch, which actuates or drives the locking bars and is locked by them.

b. (In machine with horizontal locking.) A pivot or swing

dog attached to the locking bar, and actuated or locked by the cross-locking.

WIRE CARRIER.—A frame with roller support for the wire line.

WIRE RUN.—An assemblage of wire lines of an interlocking plant, with their carriers and foundations, in a common course.

*CONVENTIONAL SIGNS.

(Conventions.)

RECOMMENDED PRACTICE.

Two-Position Mechanical Interlocking Home Signal.

Two-Position Mechanical Interlocking Distant Signal.

Two-Position Mechanical Interlocking Dwarf Signal.

Three-Position Mechanical Interlocking Home Signal.

Three-Position Mechanical Interlocking Distant Signal.

Two-Position Semi-Automatic Interlocking Home Signal.

Two-Position Semi-Automatic Interlocking Distant Signal.

Three-Position Semi-Automatic Interlocking Home Signal.

Three-Position Semi-Automatic Interlocking Distant Signal.

* Adopted, Vol. 7, 1906, pp. 515-521, 548.

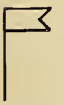
Two-Position Slotted Interlocking Home Signal.

Two-Position Slotted Interlocking Distant Signal.

Three-Position Slotted Interlocking Home Signal.

Three-Position Slotted Interlocking Distant Signal.

Two-Position Automatic Home Signal.



Two-Position Automatic Distant Signal.

Three-Position Automatic Home Signal.

Three-Position Automatic Distant Signal.

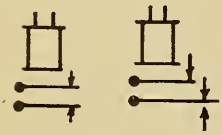
Ground Route Signal.

Suspended Dwarf Signal.

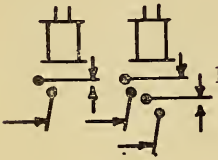
Pot Signal.

Circuit Controller on Lever, Mechanical Interlocker, normally open.

Circuit Controller on Lever, Mechanical Interlocker, normally closed.

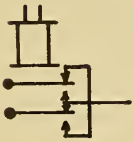


Direct Current Relays, common.



Direct Current Relays, polarized.

Direct Current Relays, Semaphore Indicator.



Direct Current Relays, pole changing.

Direct Current Relays, differential.

TOWER INDICATORS.

Semaphore, Disc. Stop When Energized.

Semaphore, Disc. Proceed When Energized.

Signal Repeater. Stop or Proceed When Energized.

Semaphore, Disc, with Bell.

Disappearing Disc.

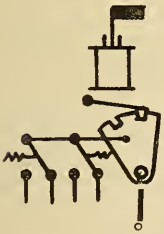
SWITCH INDICATORS.

Semaphore, Disc, with Switchbox.

Semaphore, Disc, without Switchbox.

ELECTRIC LOCK AND INDICATING CIRCUIT CONTROLLER.

For Mechanical Interlocking Machine, Operated from Quadrant of Lock.



Hand Operated.

BATTERY HOUSES.

Above Surface.

Below Surface.

Half Above Surface.

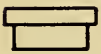
Track Battery.

Battery Chute, Relay Box and Post. Left figure indicates Capacity of Chute; right figure capacity of Relay Box.

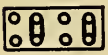
Relay Box and Post. Figure indicates capacity.

Battery Chute. Figure indicates capacity.

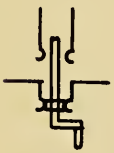
Electric Lock.



Battery Cupboard.



Switch Box.



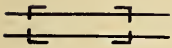
Spring Screw Release.

Switch Bell.

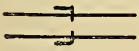
Switch Box Location.

Crossing Bell.

Relay Box. Figure indicates capacity.



Short Track Circuit.



Circuit on Right only, Insulated Joints.

Circuits Right and Left.

Signal Circuit Breaker (Closed).

Signal Circuit Breaker (Open).

Circuit Switch.

Floor Push.

SPRING HAND KEYS.

Normally Closed.

Normally Open.

Normally Open or Closed.

Bell.

Wires Cross.

Wires Join.

Lightning Arrester.

Pole Changing Switch.

Ground.

*COMPENSATION OF PIPE LINES.

RECOMMENDED PRACTICE.

Allowance for temperature should be made in accordance with table (Fig. 8). (See page 165.)

†TRAIN-ORDER SIGNALS.

RECOMMENDED PRACTICE.

The American Railway Association's third and fourth requisites of installation of interlocking plants are: (3) "Signals, if practicable (to be) either over or upon the right of and adjoining the track to which they

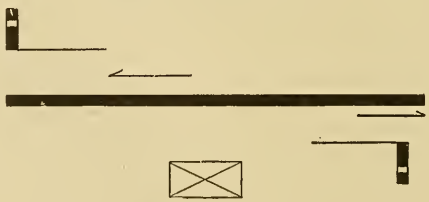


FIG. I.

* Adopted, Vol. 4, 1903, pp. 298, 299, 346; Vol. 8, 1907, pp. 77, 78, 91.
† Adopted, Vol. 4, 1903, pp. 295-297, 299, 315-346.

refer." (4) "Semaphore arms that govern (to be) displayed to the right of the signal mast as seen from an approaching train."

The *first* recommendation, therefore, of your Committee is that these two requisites be adopted with reference to *fixed* train-order signals for all numbers of tracks from one up, as illustrated in Figs. 1 and 2.

The *second* recommendation is that where it may be deemed advisable, for special reasons, to use a bracket mast, no more than two up-

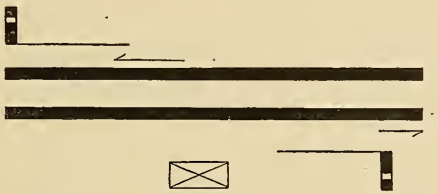


FIG. 2.

rights be placed on the bracket. One of these uprights may be a stub to indicate a track not signaled. In other words, no more than one track should intervene between a bracket signal mast and the track for which its left upright carries the signal arm. This is illustrated in Fig. 3.

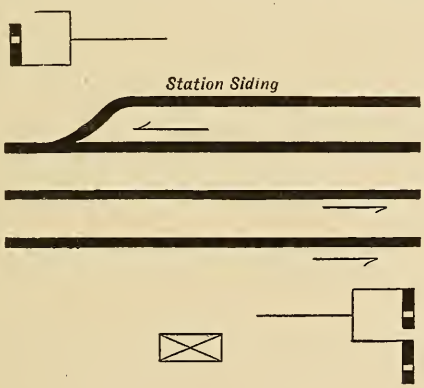


FIG. 3.

The *third* recommendation of your Committee is the recognition of the use of flags and hand lamps.

It seems to your Committee that it is proper to recognize the current practice of using flags by day and hand lamps by night. It is important, though, that a regular place for displaying these be predetermined, and

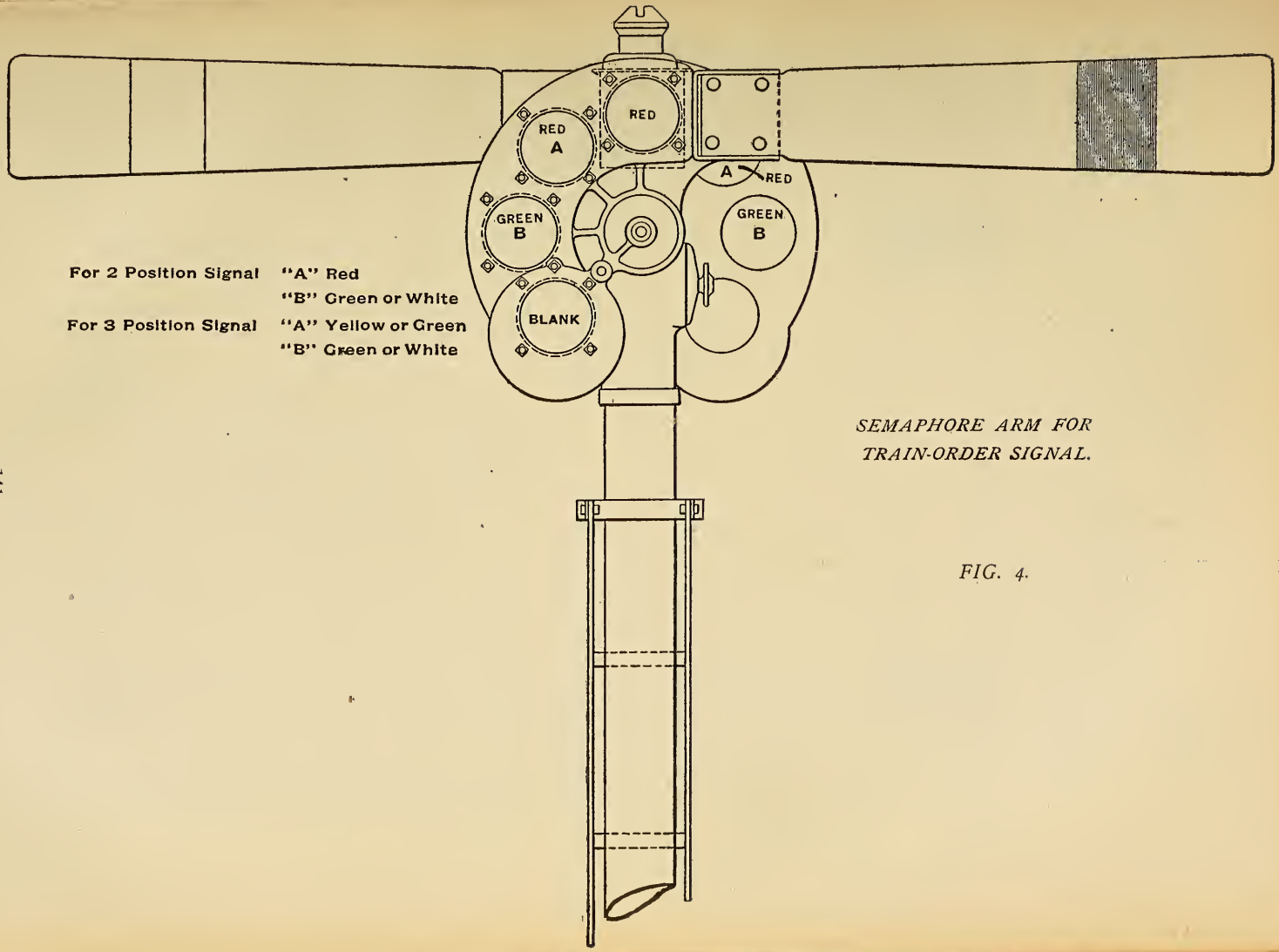
there seems to be no better way than to place a regular flag socket with hook on the side of the signal station toward the direction of the approaching train, and convenient for the operator to reach from one of the windows.

The *fourth* recommendation is the definition of "Train-Order Signal," as follows: "A fixed signal of two indications, which in the stop position informs the engineman and conductor that they are to receive orders at the telegraph office, and in the clear position announces that there are no orders for them."

The *fifth* recommendation is that this Association recommends as the best practice a fixed train-order signal, with a sweep of arm of 90 degrees from the horizontal.

The *sixth* recommendation is that the plan of a fixed train-order signal with a sweep of arm of 90 degrees, and with a spectacle casting arranged on the continuous-light principle, as shown in Figs. 4, 5, 6 and 7, be adopted as a recommended standard of the American Railway Engineering and Maintenance of Way Association.

This signal is suitable for either a train-order, or interlocking, or automatic block signal. It can be used for either two or three indications, and is suitable for those roads having red for "stop," green for "caution" and white for "proceed" or "no orders." Furthermore, it is adaptable for roads desiring to be more economical and put two arms on one mast for both directions, because the top of the mast can then be made flat and the lamp placed thereon. The mast, as well as the signal arm and casting, is recommended for standard, but neither the color of arm nor light is under consideration in the present report.



For 2 Position Signal "A" Red
"B" Green or White

For 3 Position Signal "A" Yellow or Green
"B" Green or White

SEMAPHORE ARM FOR TRAIN-ORDER SIGNAL.

FIG. 4.

Semaphore Arm for Telegraph
Block Signal.

Two Position.

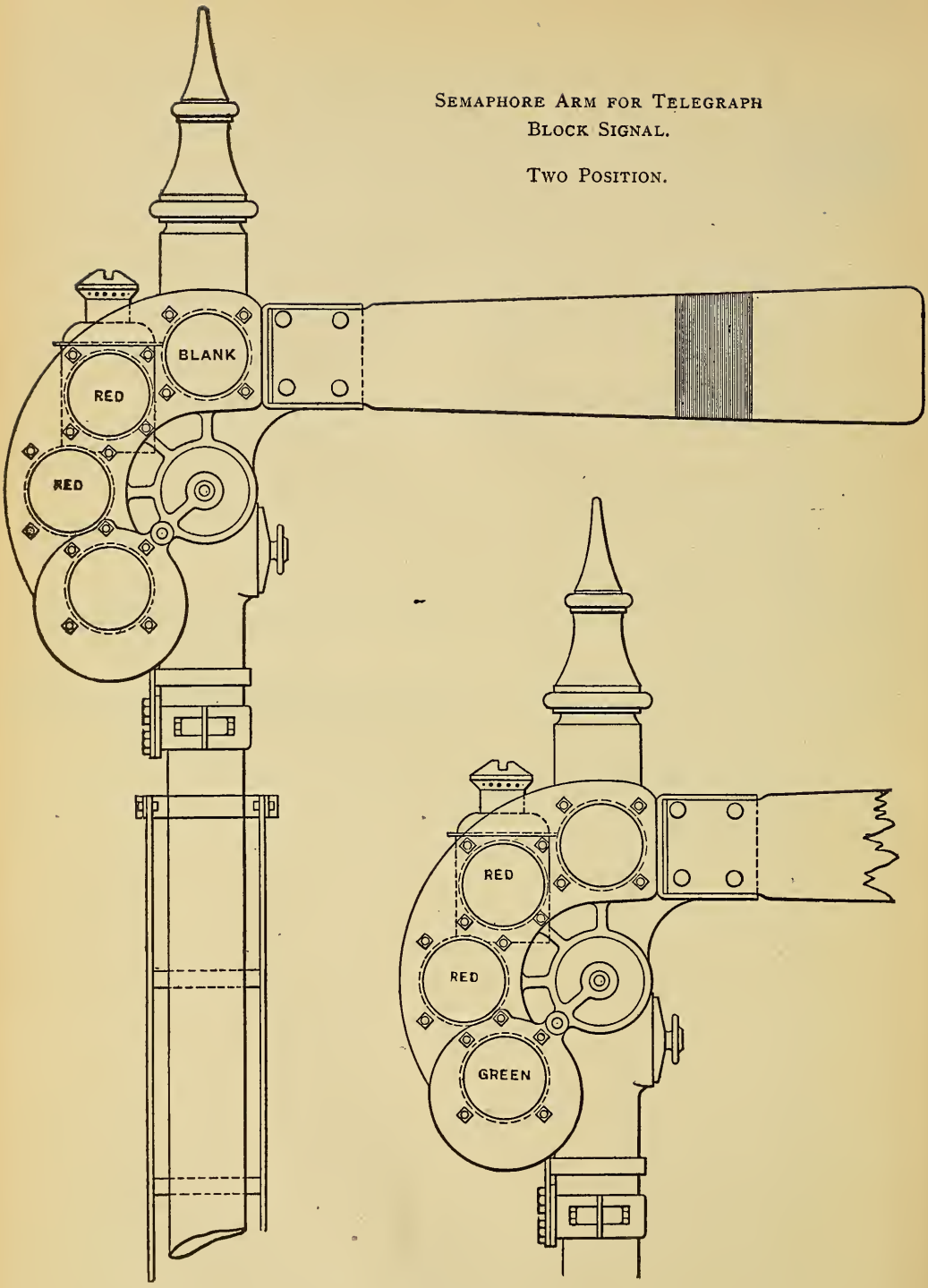


FIG. 5.

Semaphore Arm for Telegraph
Block Signal.

Three Position.

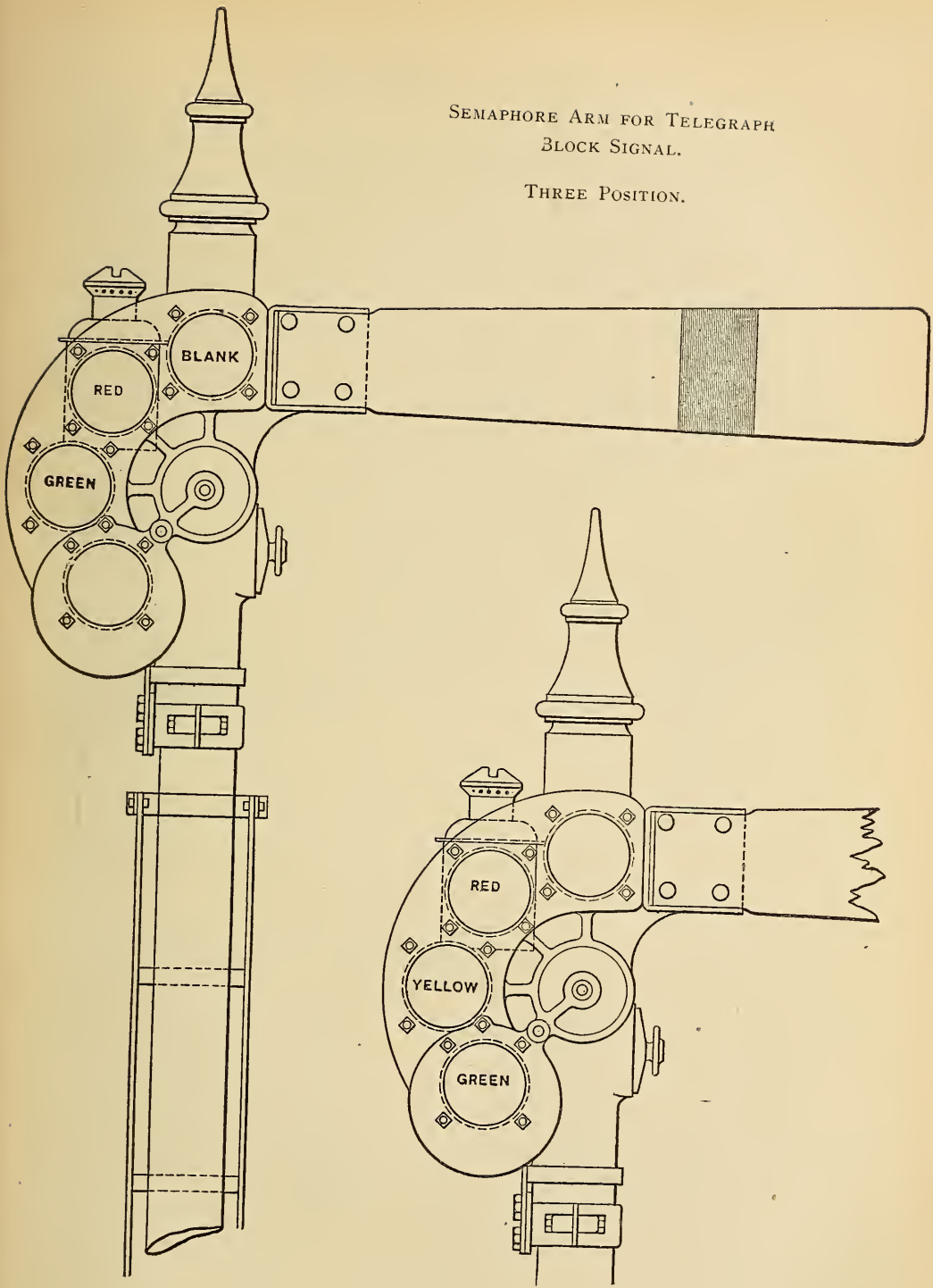


FIG. 6.

DETAIL OF SEMAPHORE ARM CASTING.

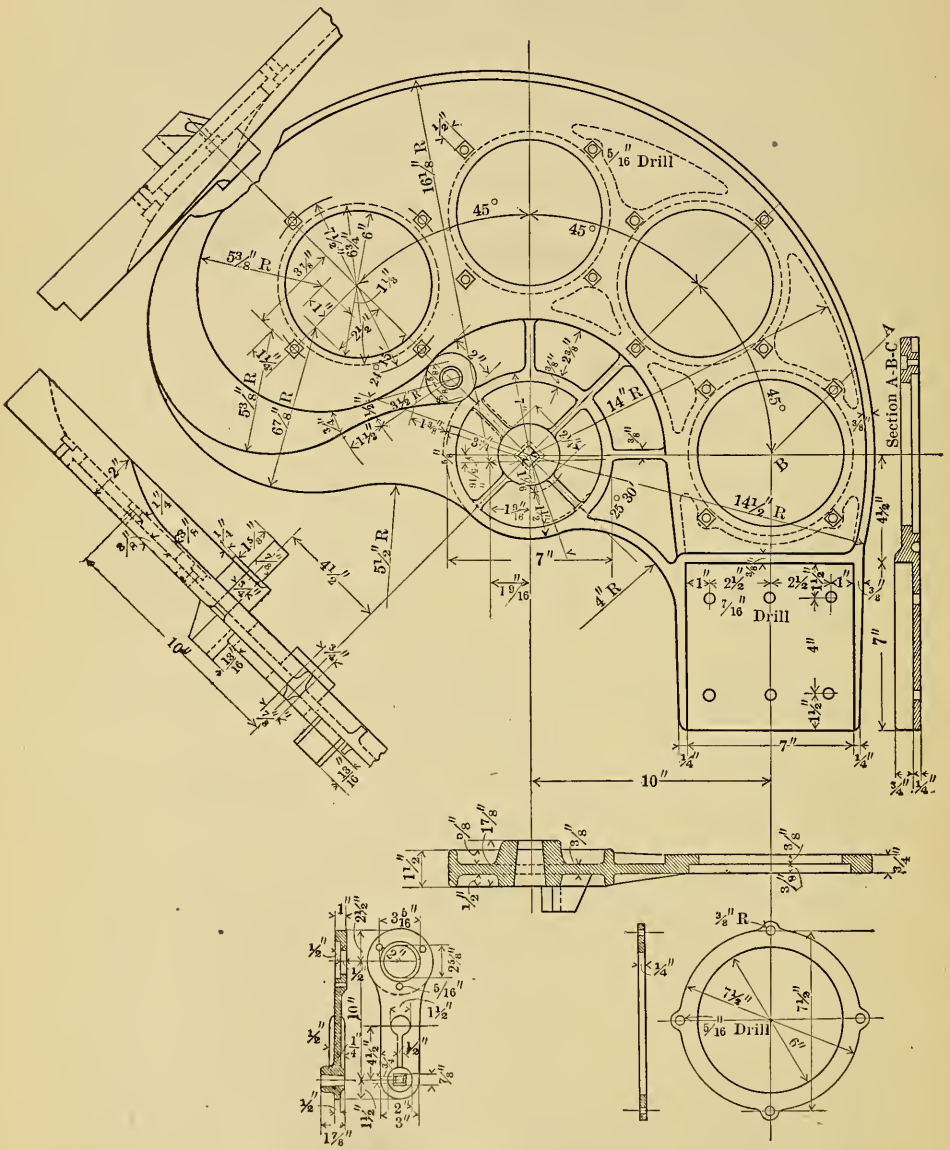


FIG. 7.

FIG. 9.

LOCATION OF COMPENSATORS AND EFFECT OF TEMPERATURE.

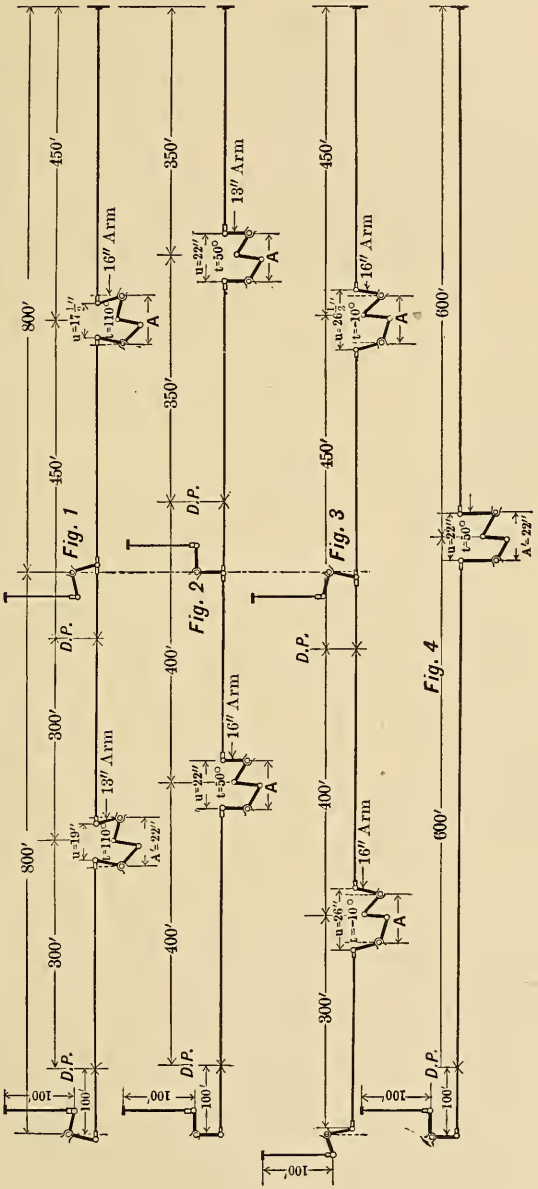
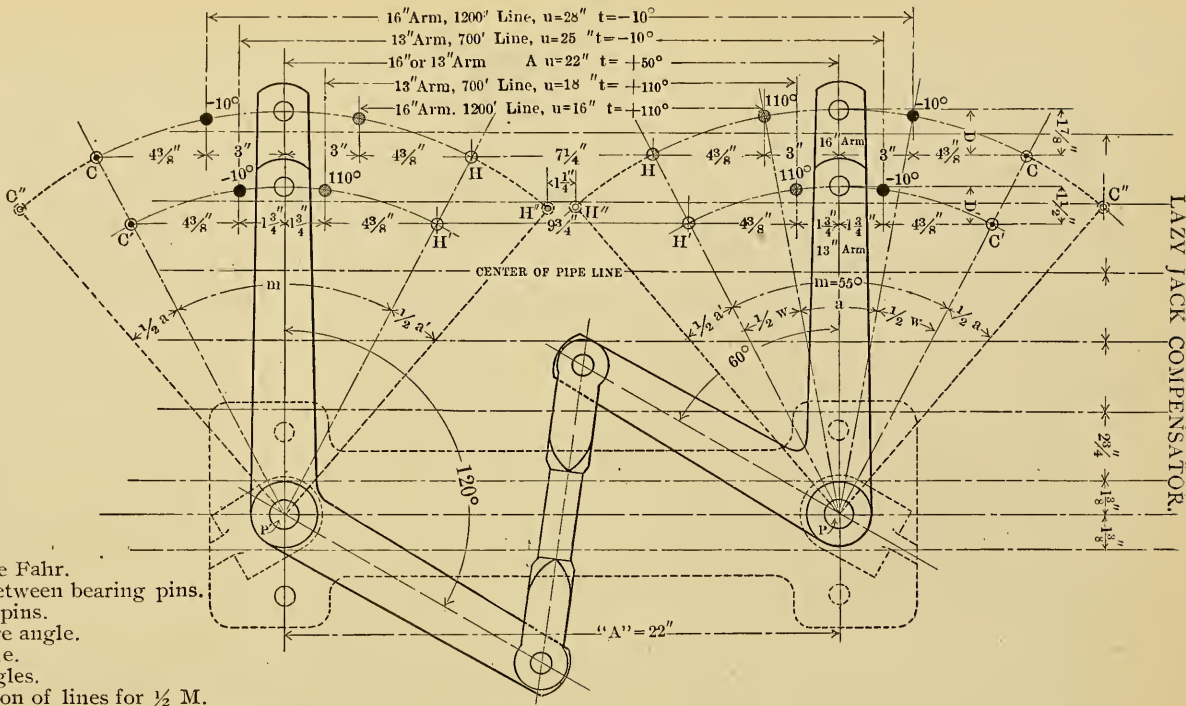


FIG. 10.



t=Temperature Fahr.
A=Distance between bearing pins.
P P′=Bearing pins.
a=Temperature angle.
u=Stroke angle.
m=A + W angles.
D D′=Deflection of lines for ½ M.
C C′=Extreme open position of arms for max. length of lines at t=10°.
H H′= " closed " " " " " " " t=110°.
C″ P& " open " of arm " 1200′ " of line at t=10°, when
C″ P′ omitting allowance for temperature in setting at t=110°.
P″ P & Extreme open position of arms for 1200′ length of line at t=110°,
H″ P′ when omitting allowance for temperature in setting at t=10°.

Note.—The values of "U" given in Fig. 10 are approximate only, the object being to show that proper clearances have been provided for, and values of "U" have been given in round numbers as maximum variations.

*TELEGRAPH, AND CONTROLLED MANUAL, BLOCK SIGNALS.

RECOMMENDED PRACTICE.

(1) The location recommended for the Telegraph, and Controlled Manual, Block Signal is on a mast alongside and to the right of the track on which are run the trains that it governs, as shown in Fig. 11; but, in the case of more than two tracks, when it is impracticable to spread them apart for this purpose, then the recommended location is on a bracket post, as in Fig. 12, or on a bridge over the tracks, as in Fig. 13.

Fig. 11
DOUBLE TRACK

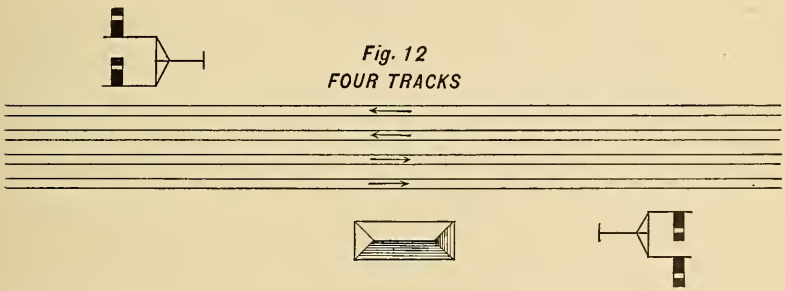


Fig. 12
FOUR TRACKS

Fig. 13
FOUR TRACKS

(2) It is good practice to make use of the electric slot to send the block signal to normal position, "Stop," as the train passes.

* Adopted, Vol. 6, 1905, pp. 518, 527, 550-551.

(3) The "Arm" for the "Telegraph" and "Controlled Manual Block Signal" to be recommended as standard by the Association is the one illustrated in Figs. 5, 6 and 7.

(4) The plan for "Leadout, Pipe-runs and Signal Connections," shown in Fig. 19, is recommended as good practice.

*LOCATION OF TELEGRAPH BLOCK SIGNALS.

RECOMMENDED PRACTICE.

(1) The arrangement shown in Fig. 14 is good practice under certain conditions for use on single-track line as a train-order signal and block signal; the signal should be located to give the best view to approaching enginemen and trainmen.

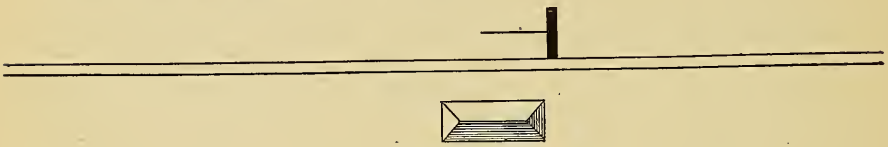


FIG. 14.

(2) Distant signals may be used with train-order and block signals, as shown in Fig. 15; the train-order signal should be located to give the best view to approaching enginemen and trainment.

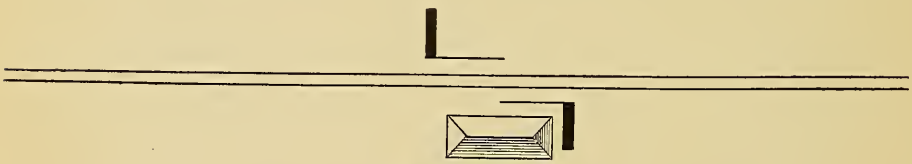


FIG. 15.

(3) The arrangement shown in Fig. 16 should be adopted when necessary to subdivide the block, and track circuit should be used in the subdivided block to control the rear signal; the train-order signal should be located to give the best view to approaching enginemen and trainmen.

* Adopted, Vol. 7, 1906, pp. 481, 482, 485, 539, 540.

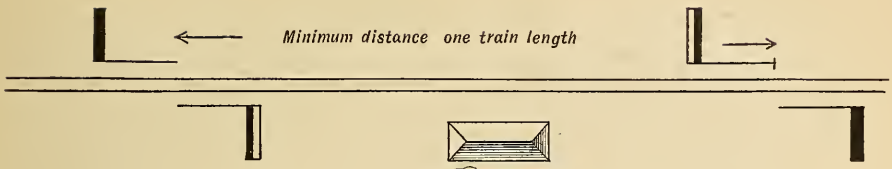


FIG. 16.

(4) The double-track arrangement, as shown in Figs. 17 and 18, should be similar to the single-track arrangement.

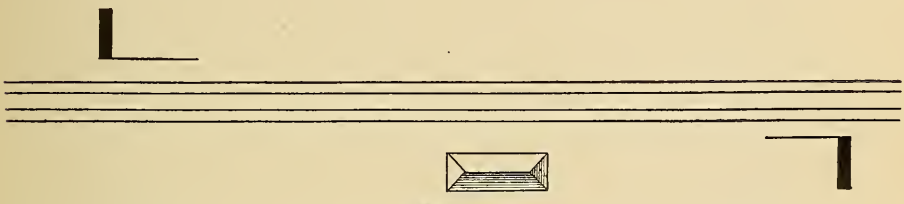


FIG. 17.

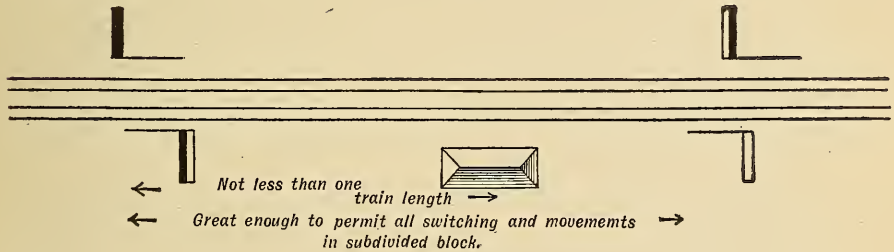


FIG. 18.

*LOCATION OF AUTOMATIC BLOCK SIGNALS.

RECOMMENDED PRACTICE.

The following diagrams show the recommended method of locating automatic signals and slotting or automatic control of interlocking signals in automatic territory.

Fig. 20 shows recommended method of double-track junction at crossing, illustrating the method of installing the automatic signals and slotting the interlocking signals on a plan of this type.

* Adopted, Vol. 7, 1906, pp. 482, 505-514, 547.

Fig. 21 shows the recommended method of location of automatic signals on single track. The use of intermediate automatic signals and controlled manual block signals at stations automatically locked by track circuit is recommended; the intermediate automatic block signals being intended for the spacing of trains running in the same direction; the automatic locking of controlled manual machines at stations being intended to take care of trains in the opposing direction. The plan of signals as shown in Fig. 21 can be adopted either in conjunction with the controlled manual automatically locked system or on single track as an adjunct to the telegraph block system for spacing of trains and at the same time take care of opposing movements in emergency.

Fig. 22 shows double-track interlocking with crossovers and an approved method of location of automatic signals and the semi-automatic control of interlocking signals.

Fig. 23 shows a recommended plan of signaling at crossovers for a four-track road, illustrating the automatic and semi-automatic features of control.

Fig. 24-A shows a recommended plan of location of automatic signals to be adopted when the length of blocks is more than 6,000 feet. In this instance, as in all double and four-track installations, where the grades vary in opposing directions, the two tracks are signaled independently of one another.

Fig. 24-B shows the two-arm signal plan to be adopted when length of blocks is less than 6,000 feet.

Fig. 25 is a plan recommended for location of automatic signals on a four-track railroad when grade will not allow the signals to coincide and the two running tracks are signaled independently of the running tracks in opposing direction.

Fig. 26 is a four-track arrangement recommended to be used in all cases when grade will allow signals to coincide.

Fig. 27 is a plan recommended for eight-track arrangement of automatic signals, it being assumed that the grade is equal in both directions.

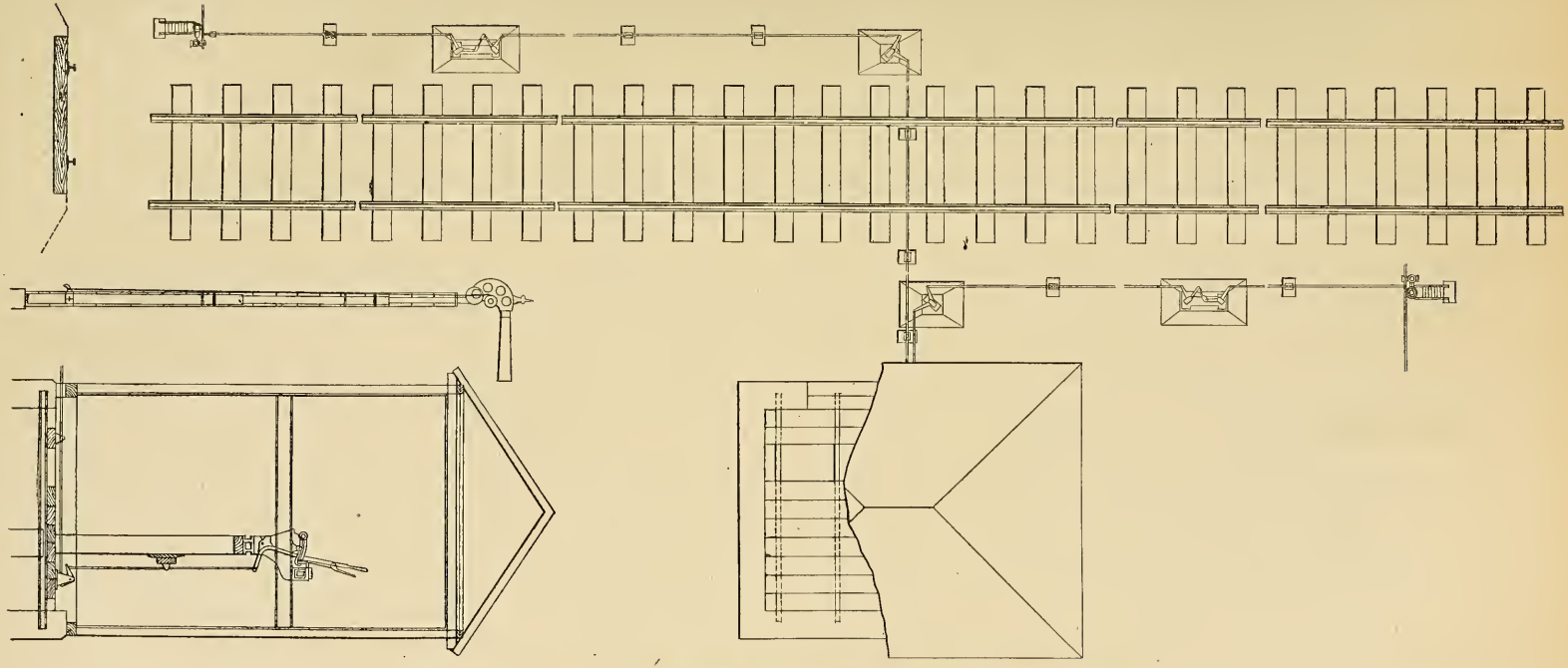


FIG. 19.—Leadout and Pipe Runs for Telegraph Block Signal.

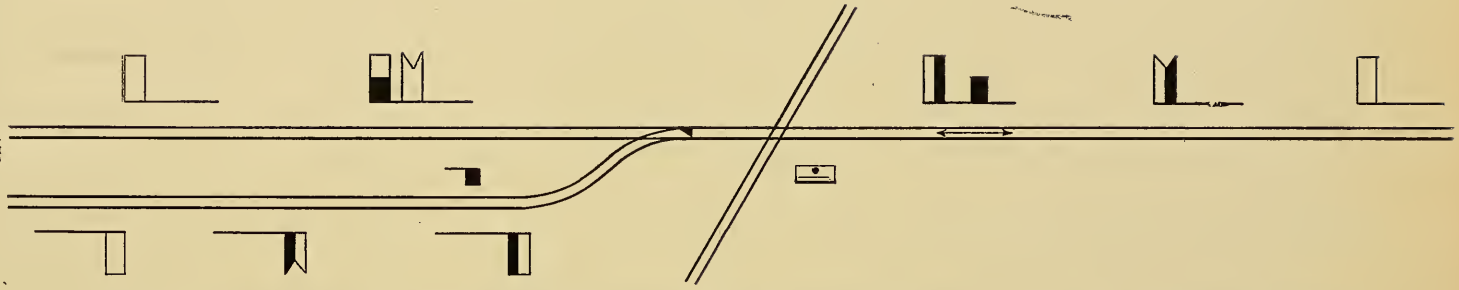


FIG. 20—DOUBLE TRACK CONVERGING TO SINGLE TRACK. INTERLOCKING SIGNALS SLOTTED AND AUTOMATIC SIGNALS.

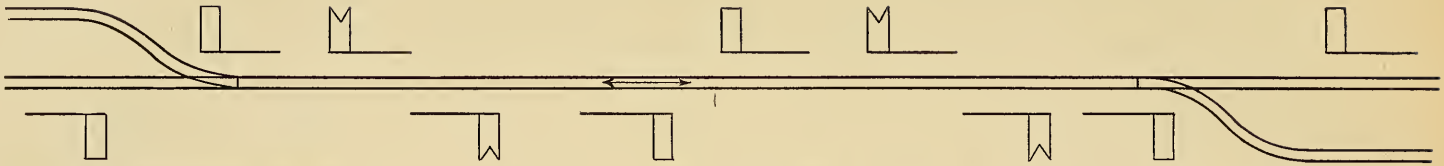


FIG. 21—RECOMMENDED METHOD. LOCATION OF AUTOMATIC SIGNALS ON SINGLE TRACK. FOR APPLICATION OF EITHER THE LOCK AND BLOCK SYSTEM OR THE STRAIGHT AUTOMATIC IN CONJUNCTION WITH THE TELEGRAPH BLOCK SYSTEM.

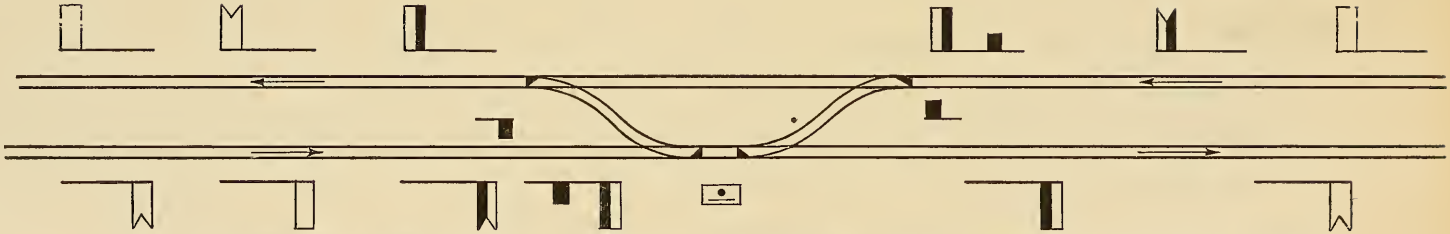


FIG. 22—DOUBLE-TRACK INTERLOCKING AT CROSSOVERS. INTERLOCKING SIGNALS SLOTTED AND AUTOMATIC SIGNALS TAKEN IN CONJUNCTION.

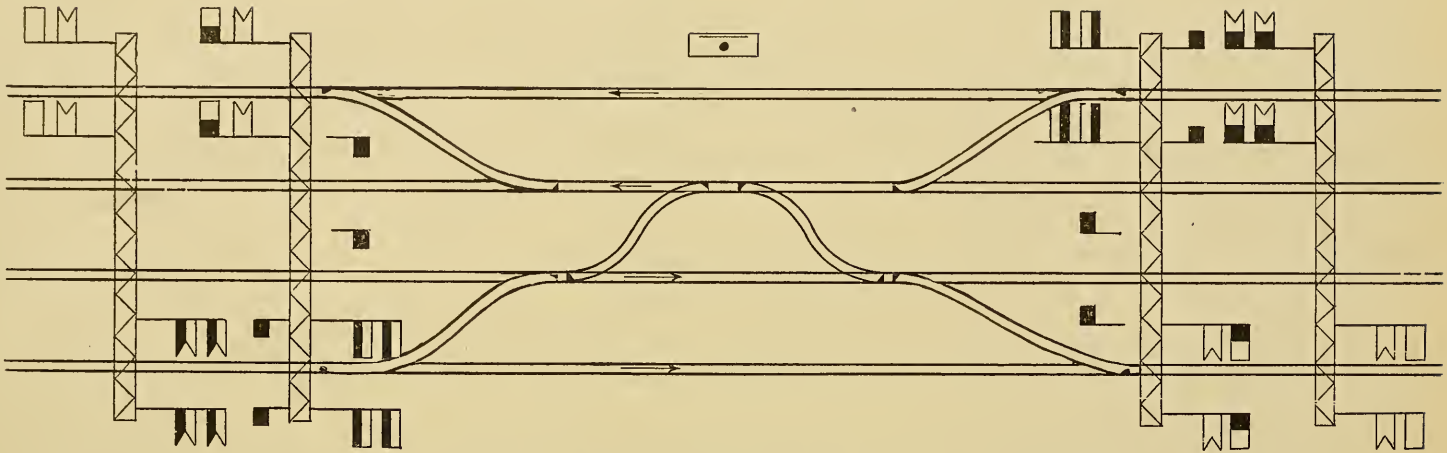


FIG. 23—FOUR-TRACK INTERLOCKING. RECOMMENDED ARRANGEMENT OF CROSSOVERS AND SLOTTING OF INTERLOCKING SIGNALS IN CONJUNCTION WITH AUTOMATIC SIGNALS.

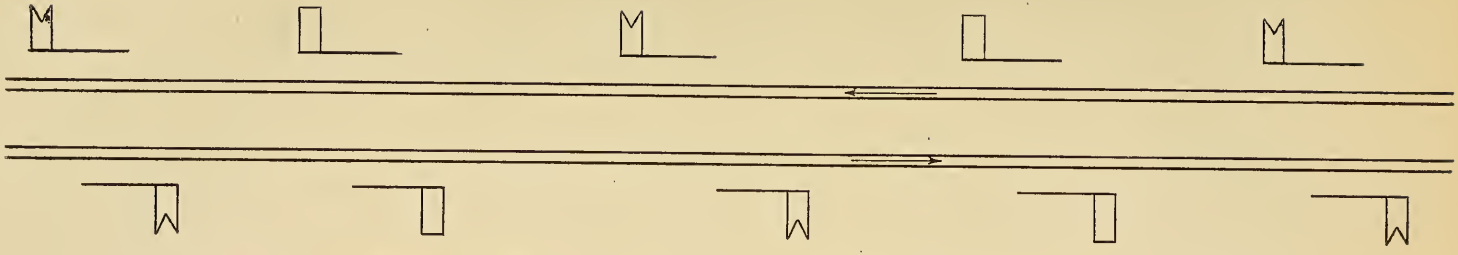


FIG. 24-A—PLAN RECOMMENDED WHEN DISTANCE BETWEEN BLOCKS IS MORE THAN 6,000 FEET. EACH TRACK TO BE SIGNALED INDEPENDENT OF THE OTHER.

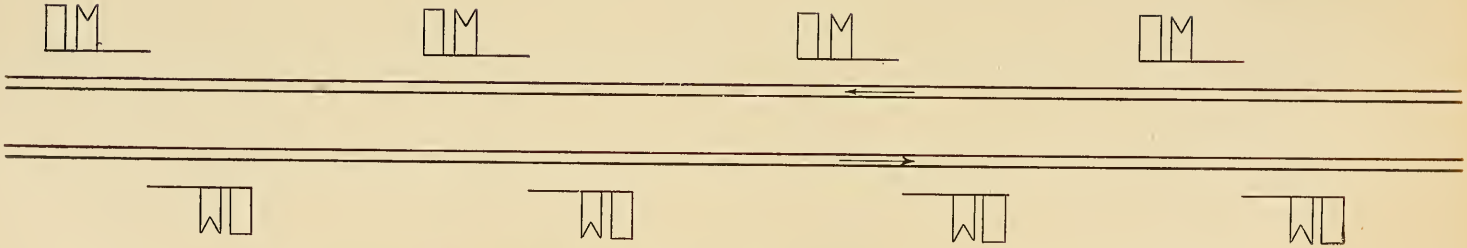


FIG. 24-B—PLAN RECOMMENDED WHEN DISTANCE BETWEEN BLOCKS IS LESS THAN 6,000 FEET.

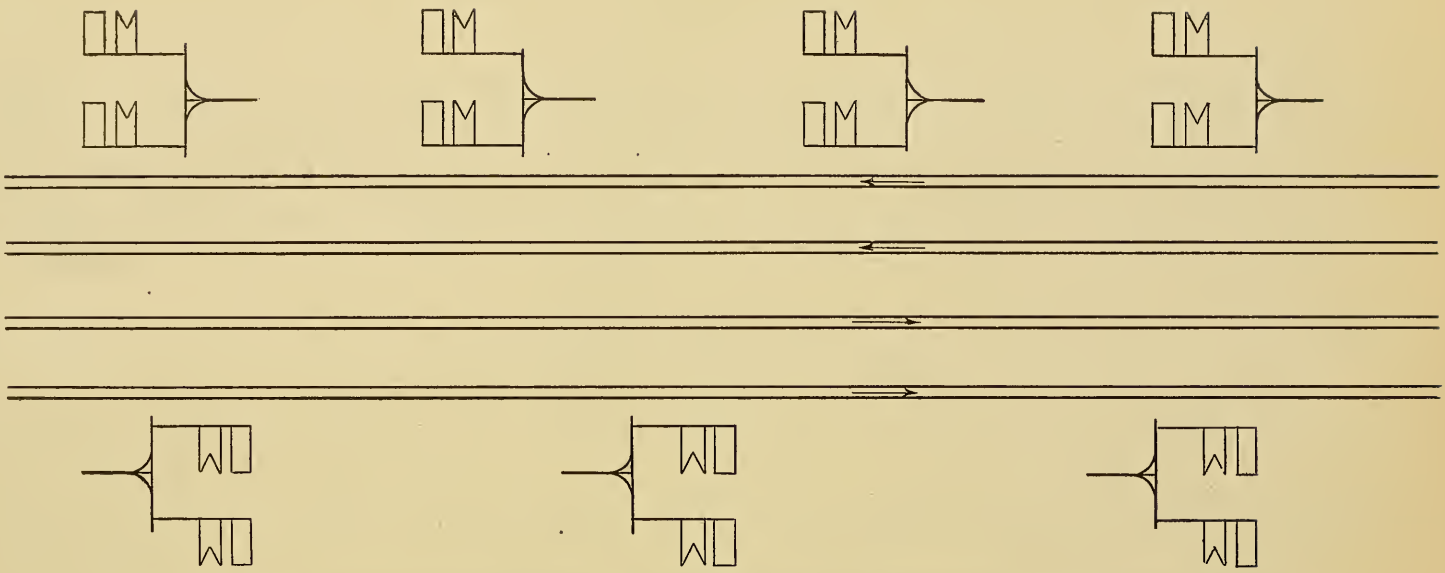


FIG. 25—FOUR-TRACK ARRANGEMENT OF AUTOMATIC SIGNALS WHEN GRADES IN THE OPPOSITE DIRECTION WILL NOT ALLOW SIGNALS TO COINCIDE.

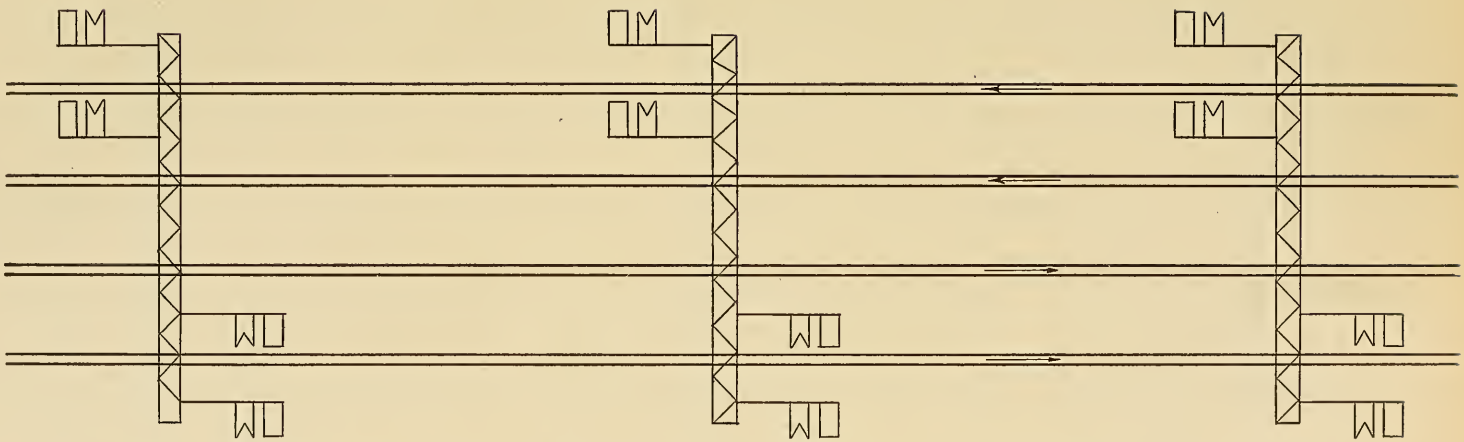


FIG. 26—FOUR-TRACK ARRANGEMENT OF AUTOMATIC SIGNALS WHEN GRADES WILL ALLOW SIGNALS TO COINCIDE.

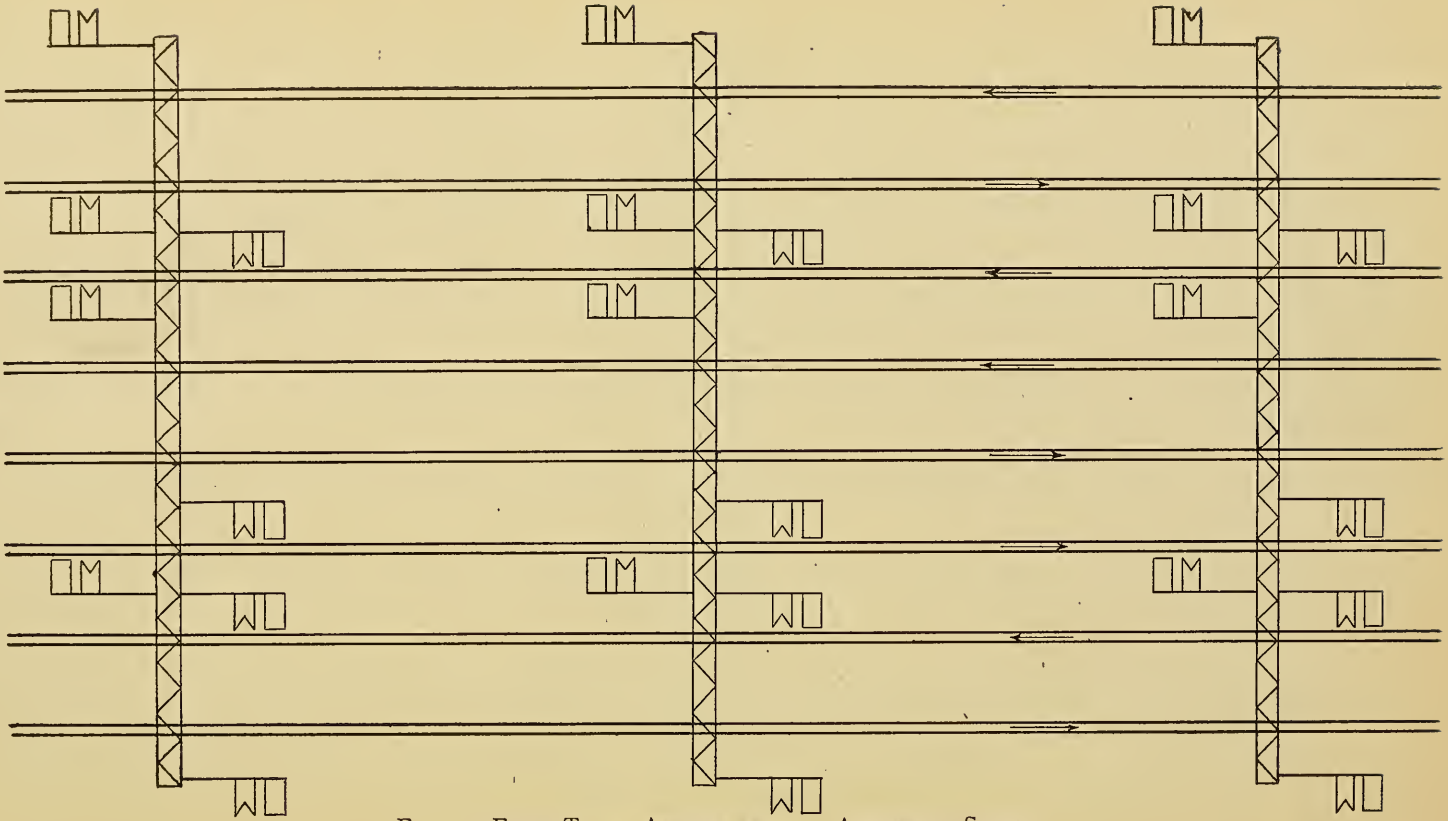


FIG. 27—EIGHT-TRACK ARRANGEMENT OF AUTOMATIC SIGNALS.

*ARRANGEMENT OF SIGNALS AT INTERLOCKING PLANTS.

RECOMMENDED PRINCIPLES OF PRACTICE.

Inasmuch as interlocking signal plants were introduced to make the passage of trains safe at speed over track layouts more or less complicated by crossovers, turnouts, and crossings, the object in arranging interlocking signals is primarily to indicate *routes* for trains, and, secondarily, as a necessary consequence, *speeds* for trains; therefore it is recommended—

(1) That high-speed movements be governed by high signals, and low-speed movements be governed by low signals.

(2) That only two high-speed signals be displayed on one mast, the top arm to govern the unrestricted speed and the lower arm to govern all other high speeds.

(3) That all low-speed movements be governed by one-arm low signals of dwarf construction.

(4) That a distant signal be provided for each high-speed route.

(5) That "red" be the "color" stop indication, and that the "horizontal" position of the arm be the "position" stop indication for all home signals.

(6) That a mark of distinction be made between automatic block signals, and all other home signals, whether interlocking, train-order, or manually operated block signals.

(7) That home block signals be provided at all interlocking plants used as block stations.

(8) That all mechanically operated high-speed signals be pipe connected. (Low-speed signals may be wire connected.)

(9) That one distant signal only shall be provided for a high-speed route, and when "clear" it shall mean that all high-speed home signals along that route through the interlocking plant, including the home block signal, are "clear."

(10) That every movement within the limits of an interlocking plant shall be governed by an interlocked signal.

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* Adopted, Vol. 6, 1905, pp. 506, 527, 547-552.

*INDICATIONS CONFERRING OR RESTRICTING RIGHTS.

RECOMMENDED PRINCIPLES OF PRACTICE.

The adoption of the following principles is recommended in view of the recent trend of the development of the art, and should not be understood as condemning the present practice endorsed by the Association as recommended good practice.

(1) It is recommended that the following principles of giving indications govern in formulating a signal system:

(a) That on all signals conferring or restricting rights, a red light shall be the night indication for "stop;" a yellow light shall be the night indication for "caution;" and a green light the night indication for "clear."

(b) That the day indication of semaphore signals be given in the upper right hand quadrant.

(c) That the semaphore arm horizontal shall indicate "stop;" inclined upward 45 degrees, "caution;" and inclined upward 90 degrees, "proceed."

†DIVISION OF EXPENSE OF INSTALLATION, RENEWAL AND MAINTENANCE OF JOINT INTERLOCKING PLANTS.

RECOMMENDED PRINCIPLES OF PRACTICE.

(1) The division of expense of the installation, renewal and maintenance of joint interlocking plants should be divided on a unit basis according to the following table:

NAME OF OPERATED UNIT.	VALUE.
One Signal Arm	1
One Pair Switch Points	1
One Derail	1
One Pair Movable Point Frogs	1
One 50′ Detector Bar, with or without Locks	1
One Scotch Block	1
One Torpedo Machine	1
One Power Signal	1
ELECTRIC LOCKING.	
For Each Electric Lock	1
ANNUNCIATORS AND INDICATORS.	
One Route	1

* Adopted, Vol. 8, 1907, pp. 84, 97, 104.
† Adopted, Vol. 8, 1907, pp. 72, 84, 91-95.

*SPECIFICATIONS FOR MECHANICAL INTERLOCKING AND MATERIAL FOR CONSTRUCTION WORK.

RECOMMENDED STANDARD SPECIFICATIONS.

GENERAL REQUIREMENTS.

1. Except as modified by plans or specifications furnished with request for tender, the contractor shall base his bid on the conditions existing at the time of such request.

2. The contractor shall furnish all tools, material and labor, except as may be hereinafter noted, to erect and complete the work in accordance with the intent of the plans and specifications, and anything that is obviously necessary to complete or make useful any part mentioned in specifications shall be provided by the contractor, although such part is not shown by the plans.

3. The company will furnish in place all switches, derails, movable point frogs and ties for same, including ties for bolt locks and crossing bars, and will do all necessary draining, grading and blasting; also provide space for connections and any necessary municipal, state or other government permits.

4. The contractor shall frame all ties for switches, derails, movable point frogs, bolt locks and crossing bars, and do all drilling for interlocking connections.

5. All material shall be furnished f. o. b. cars on the company's lines of railway.

6. Immediately on completion of the work the contractor shall remove and dispose of all refuse made by his men and leave the buildings in condition for occupancy.

7. All threads shall be U. S. standard as far as practicable.

8. All parts shall be properly proportioned for strength, and all materials and workmanship shall be of the best quality.

9. All plans furnished by the company at the time of signing the contract shall be considered a part of these specifications.

10. The contractor shall furnish the company two sets of working drawings for use during the construction, and before final payments are made shall furnish each company interested such "Vandyke" or similar prints of general installation plans, as may be required, showing the work as installed.

* Adopted, Vol. 8, 1907, pp. 73-84, 91.

11. The best practice at the time the work is performed will govern in all particulars not mentioned in these specifications, and if any devices are furnished which have not been in general use they shall be subject to acceptance of the.....(Title.)...before being placed in position.

12. The contractor shall not deviate from these specifications, except on written permission from the company, and no bills for extra work will be allowed unless such work shall have been ordered in writing.

SPECIFICATIONS FOR MECHANICAL INTERLOCKING.

INTERLOCKING STATION.

13. Interlocking station shall be built in accordance with the plans approved by the company.

INTERLOCKING MACHINE.

14. The machine must be of the preliminary latch-locking type, rigidly supported on a wood or steel frame, as required by the company, and like parts of the same type of machine shall be interchangeable as far as practicable.

15. One bracket for tappet or locking, one lever shoe pin and one locking bar extending the entire length of the machine shall be provided for each spare lever space.

16. The levers in a machine shall have equal and uniform throw. Tail levers for pipe connections shall be drilled to provide for eight and three-quarters (8¾) in., nine and three-quarters (9¾) in. and ten and three-quarters (10¾) in. movement of pipe line. Tail levers for wire connections shall be drilled to provide for ten and three-quarters (10¾) in., fourteen and three-quarters (14¾) in., sixteen and three-quarters (16¾) in. and eighteen and three-quarters (18¾) in. movement of wire line.

LEADOUT.

17. Deflecting stand, crank or rocker shaft leadout shall be furnished as specified by the company.

18. Rocker shafts shall be made from two (2) in. square, cold rolled steel, with movable bearings and movable drop forged crank arms eleven and three-quarters (11¾) in. long center to center.

Rocker shaft bearings shall be so arranged that both ends of all rocker shafts will be supported, and not more than six (6) ft. of rocker shaft will be unsupported.

19. Vertical wire leadout wheels shall be of ten (10) in. diameter.

20. Leadout appliances shall be securely fastened to leadout timbers by three-quarters (¾) in. bolts.

21. The down rod shall in all cases be connected to the eight and three-quarters (8¾) in. hole of lever, with jaw bent to fit either eight and three-quarters (8¾) in. or nine and three-quarters (9¾) in. hole by turning the rod.

22. Shackles connected to tail levers with seven-eighths (⅞) in. pins shall be provided for all wire lines and sufficient movement of wire line shall be provided to successfully operate all wire-connected signals.

PIPE LINES.

23. Pipe lines shall be used for connections to switches, derails, detector bars, locks, high home signals, Scotch blocks and torpedo machines.

24. One (1) in. soft steel or wrought-iron pipe with not less than one and one-quarter (1¼) in. outside diameter and average not less than one and sixty-seven one-hundredths ($1\frac{67}{100}$) lbs. for each linear foot of pipe alone shall be used. The ends of the pipe shall be threaded not more than one (1) in. The pipe plugs shall be drilled for one-quarter (¼) in. rivets and fastened in the pipe by one-quarter (¼) by one and eleven-sixteenths ($1\frac{11}{16}$) in. round or cone-headed rivets. Pipes shall be drilled for rivet at one end only, and be free from seams or ridges.

Sleeves for pipe couplings shall be made of wrought-iron and shall be not less than two and one-quarter (2¼) in. in length, and full section throughout.

Plugs for pipe couplings for one and sixty-seven hundredths ($1\frac{67}{100}$) pipe shall be made of wrought-iron one (1) in. in diameter and six (6) in. long, drilled and countersunk for two (2) one-quarter (¼) in. rivets, spaced four (4) in. center to center, and one (1) in. from end. Ends of plugs shall be chamfered one-eighth (⅛) in.

25. Pipe lines shall be straight where possible, and shall be not placed less than five (5) ft. from gage line, except where the line runs between tracks, or on permission being granted by the company.

Pipe lines shall be laid two and three-quarters (2¾) in. between centers, and shall be supported on pipe carriers placed seven (7) ft. centers on straight lines, and six (6) ft. centers around curve. The

distance from base on which pipe carriers are supported to the center of pipe line shall be four and one-quarter (4¼) in.

26. Couplings in pipe lines shall be located not less than twelve (12) in. from pipe carriers with lever on center.

27. Pipes leading across tracks shall be supported by transverse pipe carriers, fastened on top of ties.

28. Where pipe and wire lines cross tracks which are not parallel turns in pipe lines shall be made with cranks, radial arms or deflecting bars and in wire lines with chain wheels. Deflecting bars shall be arranged for pin connections.

29. Pipe connections shall be installed in accordance with temperature diagram.

PIPE CARRIERS.

30. Pipe carriers shall be made of best gray iron, constructed of individual top and bottom rollers, and with individual legs or strands coupled at the top and in contact but not connected at the bottom.

CRANKS.

31. Center pins of horizontal cranks shall be provided with top and bottom support. Cranks used for the operation of a switch and a lock for the same switch shall be mounted in separate crank stands.

JAWS.

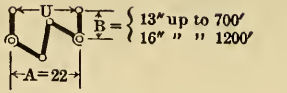
32. Body of all jaws shall be of wrought-iron one and one-quarter (1¼) in. in diameter and fitted with tang and thread for coupling to pipe. Tang shall be four (4) in. in length and one (1) in. in diameter.

33. The sides of solid jaws shall be parallel for three (3) in. and the sides of screw jaws five (5) in. from center of pin holes.

34. The length of solid jaws shall be nineteen and one-half (19½) in. from center of pin hole to center of rivet hole and the length of screw jaws the same with jaw in center of thread.

35. Each screw jaw shall be provided with a jamb nut.

36. Body of screw jaws shall be of wrought-iron, one and one-quarter (1¼) in. in diameter, with tang and thread for coupling to pipe. Tang shall be four (4) in. in length and one (1) in. in diameter. Special jaws made with tang ends or bodies of one (1) in. and three-quarters (¾) in. round may be used for immediate connections to high signals, dwarf signals, torpedoes, selectors, etc., where the resistance is less than one hundred (100) lbs.



Values of U are based on .08 of an inch as coefficient of expansion for an increase of 10° Fahr. for each 100 ft. of line, and the nearest 1-16 inch is given.

FIG. 8.—VALUES OF SPACING "U" FOR GIVEN TEMPERATURES AND LENGTHS OF LINES TO BE COMPENSATED.

TEMP F°	LENGTH OF LINES COMPENSATED IN FEET											
	100	200	300	400	500	600	700	800	900	1000	1100	1200
110°	21½″	21″	20½″	20″	19½″	19″	18½″	18″	17½″	17″	16½″	16″
90°	21 1/16″	21⅜″	21″	20 1/16″	20⅜″	20″	19 1/16″	19⅜″	19″	18 1/16″	18½″	18¼″
70°	21 3/16″	21 1/16″	21 9/16″	21⅜″	21 3/16″	21″	20⅞″	20 1/16″	20½″	20⅜″	20¼″	20⅛″
50°				MEAN	TEMPER	ATURE	U=A=22″					
30°	22 3/16″	22 5/16″	22½″	22⅝″	22 13/16″	23″	23 3/16″	23 5/16″	23½″	23⅝″	23¾″	23 15/16″
10°	22 5/16″	22⅝″	23″	23 5/16″	23⅝″	23 15/16″	24¼″	24 9/16″	24⅞″	25 3/16″	25½″	25⅞″
0°	22 7/16″	22 13/16″	23¼″	23⅝″	24 1/16″	24 7/16″	24 13/16″	25¼″	25 1/16″	26⅛″	26½″	26 13/16
−10°	22½″	23″	23½″	24″	24½″	25″	25½″	26″	26½″	27″	27½″	28″

Since the mean temperature varies, it must be taken for the latitude where the work is done.

OFFSETS.

37. Offsets in pipe lines shall be made in jaws, or in iron rod one and one-quarter (1¼) in. in diameter. The total offset between any two supports shall never exceed two and three-quarters (2¾) in. No offsets shall be made in cranks to exceed one and one-quarter (1¼) in.

COMPENSATORS FOR PIPE LINES.

38. A compensator shall be provided for each pipe line over fifty (50) ft. in length and under eight hundred (800) ft., with crank arms eleven by thirteen (11x13) in. centers. From eight hundred (800) to twelve hundred (1,200) ft. in length, crank arms shall be eleven by sixteen (11x16) in. centers. Pipe lines over twelve hundred (1,200) ft. in length shall be provided with an additional compensator.

Compensators shall have one sixty (60) degree and one one hundred and twenty (120) degree angle cranks and connecting link, mounted in cast-iron base, having top of center pins supported. The distance between center of pin holes shall be twenty-two (22) in.

LOCKS.

39. Facing point locks shall be used on all switches and derails.

40. Lock castings shall be placed on outside of tracks and bolted to tie through a tie plate one-half by six (½x6) in. placed on top of tie and securely fastened thereto.

41. Plungers shall be one (1) in. in least dimension and twenty (20) in. in length; have a stroke of eight (8) in, and stand not more than one (1) in. clear of lock bar when switch is unlocked, and the locking ends shall be square.

42. Lock rods for facing point locks shall be run direct without side bend or goose neck from front rods into lock castings. Holes in lock bar shall have square edges and shall be not more than one and one-sixteenth (1 1/16) in. in least dimension.

43. Facing point switches, derails and movable point frogs on high speed routes shall be bolt locked with signals governing such route.

In all cases where switch and lock movements are used, bolt locks shall also be used.

44. The switch bar on all bolt locks shall have an independent connection to switch point.

45. The signal bar on bolt lock shall be made of mild steel and be a part of the line and not lugged or looped in. The switch and

signal bars shall be five-eighths by one and three-quarters (⅝x1¾) in. section. The notch in the signal bar shall not be more than one and one-half (1½) in. in length. When two or more signal bars are used in one bolt lock, they shall be so arranged that each bar must enter its proper slot in the switch bar.

DETECTOR BARS.

46. Detector bars shall be arranged to give fifty (50) ft. continuous protection for all switches, derails and movable point frogs.

47. Detector bars shall be made of three-eighths by two and one-quarter (⅜x2¼) in. steel, have square ends and bolted joints; fifty (50) ft. bars shall consist of three pieces.

48. Detector bars shall be placed on outside of rails, and move in a plane inclined toward center of track; on curves the bar shall be placed alongside of the outer rail. Top of bar shall stand one-quarter (¼) in. below top of rail when lock lever is at end of stroke and shall rise not less than three-quarters (¾) in. above rail.

49. Supports shall be placed six (6) in. and twenty-four (24) in., respectively, from the ends, and the remaining supports not over four (4) ft. apart. The driving piece shall be placed midway between two supports and the driving rod shall be not less than six (6) ft. in length, except when rocker shafts are used. Connection from pipe line to driving piece shall be as nearly parallel with the track as possible. The crank end of driving rod shall be located not more than eight (8) in. from outside of rail. Where rocker shafts are used they shall be made from two (2) in. square cold rolled steel, with movable bearings and crank arms interchangeable with leadout rocker shafts.

50. Where detector bar overlaps switches, special rail braces shall be provided by the company.

SWITCH AND LOCK MOVEMENTS.

51. Switch and lock movements shall be used for derails, Scotch blocks and torpedo machines only, and not more than one (1) shall be connected to a lever.

ADJUSTMENTS.

52. One turnbuckle shall be put in each pipe line between the two foundations nearest the crank at switch and lock movement and facing point lock.

Wire lines for distant signals shall be provided with two adjusting screws for each wire—one in tower and one at base of signal pole.

53. Turnbuckles shall be made of wrought-iron, with right and left hand thread, and be capable of giving an adjustment of not less than six (6) in.

54. Wire adjusting screws shall be made of wrought-iron, not less than one-half (½) in. in diameter, with right and left hand thread, and shall be capable of giving an adjustment of not less than twelve (12) in.

55. Switches, derails and movable point frogs shall be provided with a special adjustment riveted to the head rod.

56. Split point derails shall open not less than three and one-half (3½) in. Lifting derails shall open not less than five (5) in.

57. Switches and movable point frogs shall open not less than four (4) in.

58. Where bolt locks are used, screw jaws or adjusting screws shall be placed in the signal line on each side of the bolt lock.

SIGNALS.

59. The height of dwarf signal poles shall be such that the lower signal arm will stand not more than one and one-half (1½) ft. above top of rail in normal position.

60. Semaphore arms on the same high pole shall be placed not less than six (6) ft. from center to center.

61. High signal arms shall be made of well-seasoned, clear white ash, or equally good material. Dwarf signal arms shall be made flexible.

62. High arm castings shall be capable of holding three glasses six and one-half (6½) in. in diameter or eight and three-eighths (8⅜) in. in diameter and one-quarter (¼) in. in thickness. The back light shall be two (2) in. in diameter. Dwarf signal castings shall be capable of holding two glasses six and one-half (6½) in. in diameter and furnished with glasses two (2) in. in diameter when required.

63. Up and down rods for signals shall be guided every six (6) feet and so connected to the arm castings that the arms will be pushed to the clear position.

64. Signals shall be provided with counterweights to assist arm to gravitate to the horizontal position.

65. On wire connected signals, the counterbalance lever shall be set parallel with the tracks.

WIRE.

66. Signal wires shall be unannealed galvanized steel No. 9 B. W. G. (.150-in. in diameter). The wires shall be cylindrical, free from scales, inequalities, flaws, splits and other defects. Each coil shall consist of one continuous wire not less than 2,500 ft. in length, without joints, and shall be at least five (5) ft. in diameter.

WIRE CONNECTIONS.

67. Two wires shall be used for operating each wire connected signal; the normal operating wire shall have one and one-half (1½) in. more stroke than the reverse operating wire.

68. Wire lines shall be carried in wire carriers on stakes placed not more than twenty-one (21) ft. apart and not less than six (6) ft. from gage side of nearest rail, except where they can be conveniently carried on pipe line foundations, in which case three (3) in. blocks shall be used to keep wire above intervening foundations.

69. Where wire lines lead around curves, the carriers shall be placed at the proper angle to prevent wire leaving groove of pulley.

70. Turns in wire lines shall be made around wheels with continuous pieces of chain made of one-quarter (¼) in. iron.

WHEELS.

71. Chain wheels shall be of cast-iron ten (10) in. in diameter, except on dwarf signals, which may have a minimum diameter of six (6) in. Not more than three wheels are to be arranged in the same vertical line.

WIRE CARRIERS.

72. Sheaves shall be two (2) in. in diameter over all.

WIRE THIMBLES.

73. Standard three-quarters (¾) in. thimbles shall be used in making wire connections.

SPLIT LINKS.

74. Split links shall have three-quarters by one and one-half (¾x1½) in. inside dimensions and be made of five-sixteenths (5-16) in. steel. After connections are made points shall be closed.

LAMPS.

75. Lamps shall be furnished by the company.

FOUNDATIONS.

76. Pipe carrier foundations shall be concrete, 8x12x24 in., and have top of white oak, two and one-half by eight (2½x8) in. The top shall be fastened to the foundation by two one-half by ten (½x10) in. hook bolts.

77. Cranks and compensators shall be bolted to cast-iron piers set in a block of concrete not less than two and one-half by four by three (2½x4x3) ft.

78. Foundations for Lazy Jack compensators and dwarf signals shall be concrete, not less than two and one-half by four by three (2½x 4x3) ft.

79. The iron piers, cranks, compensators and wheels shall be arranged with slots to hold three-quarters (¾) in. bolts. Plank to hold dwarf signals and deflecting bars to be fastened in a similar manner.

80. Foundations for iron bracket poles shall be of concrete, not less than four by four by five (4x4x5) ft.

81. Wood top for dwarf signal and deflecting bar foundations shall be three by twelve (3x12) in. white oak.

82. Foundations shall be so constructed that apparatus can be removed without disturbing foundations.

83. Wood stakes for wire lines shall be three in. by four in. by four ft. (3x4 in. x4 ft.) with seven (7) in. point.

84. Foundations shall stand at least ten (10) days after concrete work is done before being connected to the apparatus.

PINS.

85. Pins shall be made of steel, accurately turned and provided with cotters.

86. Center pins for cranks, compensators and switch and lock movements shall be one and one-quarter (1¼) in. in diameter and shall be provided with a square head or other means for conveniently turning or removing same.

87. Connecting pins for cranks, compensators, levers, selectors, signals, bolt locks, switches, etc., shall be seven-eighths (⅞) in. in diameter and have square heads.

BOLTS AND SCREWS.

88. Bolts shall have standard square or hexagon head and nuts.

89. Lag screws shall be standard, with square heads.

90. Two one and one-half (1½) in. No. 14 drive screws shall be used to fasten each wire carrier to its foundation.

91. Six three-eighths by one and one-half (⅜x1½) in. elevator bonds, with head one and one-quarter (1¼) in. in diameter, shall be used to fasten each high signal arm to casting.

92. Two one-quarter by one (¼x1) in. bolts shall be used to fasten low signal arm to casting. A single plate washer one-eighth by three-quarters (⅛x¾) in. shall be used under bolt heads.

93. Plate washers shall be used under bolt heads, nuts and heads of lag screws where they would otherwise come in contact with wood.

PAINTING.

94. The machine shall be painted one priming coat and finished with two coats of black, to and including the latch shoe. The levers shall be painted three coats, as follows:

Lock levers, blue.

Distant signal levers, lawn green, or lemon-yellow.

Home signal levers, vermilion.

All other levers, black.

95. When a lever is used for more than one purpose, it shall be painted to correspond with the colors used on separate levers for same purposes.

96. The unfinished part of latch handle inside shall be painted same color as lever.

97. Painted parts of machine above floor shall have one coat of varnish.

98. The finished parts of the machine shall not be painted.

99. Signal arms shall be painted one coat of priming and two finishing coats.

100. Signal poles shall be given a priming coat of graphite paint and a finishing coat in accordance with company's standard.

101. Iron work, except detector bars, tie plates and iron foundations, shall be painted two coats of graphite paint.

102. Chain and other iron work, not machine finished, shall be dipped in oil before being shipped.

103. Boxing shall be painted two coats of metallic oxide paint.

BOXING.

104. Boxing, when it is required, shall be made of good pine lumber, surfaced on one side. Planks two by eight (2x8) in. shall be used for the sides and tops, and, if necessary, one (1) in. rough lumber for bottom. All pipe and wire lines shall be boxed for six (6) ft. from rail where they cross tracks; and where highways are crossed boxing with four (4) in. oak for top and sides shall be used. Where wires cross highways they must run in one-half (½) in. galvanized pipe, provided with a stuffing box in each end, pipe to be filled with black oil.

COMMITTEE NO. XI.

RECORDS, REPORTS AND ACCOUNTS.

*RECORDS, REPORTS AND ACCOUNTS.

DEFINITIONS.

RECORDS.—Information or data in graphical, tabular or statement form relating to the physical characteristics, condition, cost and such other information as may seem desirable for record.

REPORTS.—The medium through which information is transmitted from one to another official and from which records and accounts are prepared or compiled in the filing office.

ACCOUNTS.—Statements required to enable payments to be made for labor performed and material furnished, or to establish the detail, total and comparative cost of work and various classes of expenses.

LEDGER ACCOUNTS FOR INDIVIDUAL PIECES OF WORK.—Statements kept in ledger form in order to establish the detail, total and comparative cost of any particular work or class of expenses.

CONVENTIONAL SIGNS.—Symbols, such as a mark, character, abbreviation or letter selected or sanctioned by general agreement and used to indicate upon a map or plan certain forms, conditions and objects both natural and structural.

PROGRESS PROFILE.—A graphical record of the progress of work prepared at stated periods.

TRACK CHART.—A diagram showing the physical characteristics of track and roadbed.

†FILING DUPLICATE RECORDS IN SEPARATE LOCALITIES FOR PROTECTION IN CASE OF FIRE.

RECOMMENDED PRACTICE.

Duplicate copies of record books and maps, particularly right-of-way maps, should be kept in quite widely separated localities, so that the trouble and expense of reproducing the same will be greatly reduced in case of fire or accident.

* Adopted, Vol. 7, 1906, pp. 279, 318.
† Adopted, Vol. 5, 1904, pp. 286, 371, 377 (see Vol. 2, 1901, p. 322); Vol. 6, 1905, pp. 658, 668.

*BRIDGE DEPARTMENT FORMS.

CONCLUSIONS AND RECOMMENDED STANDARD FORMS.

(1) The following standard forms are considered essential and recommended as the special forms for a regular working Maintenance of Way Bridge Department:

Report of Foreman of Bridges.....M. W. 1000
Monthly Bridge Material Report.....M. W. 1001
Foreman's Diary, Bridge Department.....M. W. 1002
Bridge Department Tool Report.....M. W. 1003
Structure Report .....M. W. 1004
Current Bridge Inspection Report.....M. W. 1005
Summary Current Bridge Inspection Report.....M. W. 1006
General Bridge Inspection Report.....M. W. 1007

(2) In Bridge Inspection there should be a clear distinction made between Current Inspection and General Inspection. The purpose of the Current Inspection is to keep the structure in safe condition, to promptly discover any defects and to report the same promptly, so that repairs can be made before the safety of the structure is affected. It is important that a simple record should be made while at the bridge and that the superior officer be kept advised of all such inspections promptly, whether made by a Bridge Mechanic, Gang Foreman, Division Bridge Inspector, Master Carpenter, or others.

The purpose of the General Inspection, frequently called the annual inspection, although in many cases conducted semi-annually or even quarterly, is not only to check the maintenance work of the division organization, but to make a more careful investigation of important bridges and structures on the entire road, and, further, to ascertain and determine what extensive repair work or renewal work should be done in the following working season.

(3) The general forms of the railroad should be used in all departments, including the Bridge Department, as far as applicable; for example, one form for reporting time should be used in all departments, the form being designed accordingly.

(4) Bridge records, when properly kept up to date in an accurate manner, will prove of the highest value to railroads and are essential for any system of complete and proper bridge records. However, forms in connection with bridge records are not specially necessary for a Bridge Department, but are necessary generally for the compila-

* Adopted, Vol. 5, 1904, pp. 237, 238, 372-375; Vol. 6, 1905, pp. 656, 657, 668.

tion of records for several departments, and hence these forms are not recommended as standard special Bridge Department forms.

(5) Numerous minor special forms are used on all railroads for reporting information necessary to keep bridge records up to date, but such forms should be regulated by each individual railroad, according to its peculiar requirements, and hence no standard forms for this purpose are recommended.

Size 3½ x 5½ inches. Form M. W. 1000.

A. B. & C. R. R. Co.

REPORT OF FOREMAN OF BRIDGES

_____ *Station.*

Master Carpenter,

_____ *190*__

_____

*Dear Sir:—I have completed the following work:*_____

_____

_____

_____

_____

I moved my gang on _____ *and began following work:*_____
(date)

_____

_____

Respectfully,

_____

Foreman of Bridges.

SPECIFICATIONS FOR FORM M. W. 1000.

Form as here shown. Size 3½x5½ inches. To be printed on heavy manila paper. On address side, address of Master Carpenter to be printed.

Size 8x13 inches. Form M. W. 1001.

A. B. & C. R. R. Co.

_____ Division

MONTHLY BRIDGE MATERIAL REPORT

_____ Month of _____ 190

(Gang or District.)

KIND OF MATERIAL	UNIT	ON HAND FIRST OF MONTH	RECEIVED	DISPOSED OF		ON HAND END OF MONTH	REMARKS
				USED	SHIPPED AWAY		
← 2."0 →	0."5	← 0."7 →	← 0."7 →	← 0."7 →	← 0.'7 →	← 0."7 →	← 2."0 →
THREE SPACES PER INCH							

The above statement is correct:

.....
Foreman of Bridges.

Correct: .....
Master Carpenter

Form M. W. 1001.

A. B. & C. R. R. Co.

....
(Gang or Dist.)

.....Division

MONTHLY
BRIDGE MATERIAL REPORT

For.....Ending.....190..

Foremen are required to make the above report.....and forward same to Master Carpenter, who will, after examining, approve it and forward to Division Engineer.

To be filed in the office of Division Engineer.

SPECIFICATIONS FOR FORM M. W. 1001.

Form as here shown. Size 8x13 inches. Vertical lines, red; horizontal lines, blue.

SPECIFICATIONS FOR FORM M. W. 1002.

FOREMAN'S DIARY—BRIDGE DEPARTMENT.

To be issued in book form. Size of pages, 5¼x8 inches. Size of book, 5½x8½ inches.

A. B. & C. RAILROAD COMPANY

_____

(Gang or District.)

_____ Division.

FOREMAN'S DIARY.

BRIDGE DEPARTMENT.

Month of _____ 190__

_____

Foreman of Bridges.

I certify that I have examined the within account of Material used on each job, and find it correct.

_____

Master Carpenter.

INSTRUCTIONS TO FOREMEN.

This Diary to be kept by Foreman of Bridges and sent to Master Carpenter and by latter sent to Division Engineer.

In entering in this Diary material used on different jobs you will be governed by the following rules, namely:

Enter the location, name and description of job by giving No. of each bridge or culvert in the column provided for that purpose.

Enter No. or size and name of articles used on each job in proper column, stating quantity, old or new; in case of lumber, give kind (oak, white or yellow pine, etc.).

Always show whether work is complete or not complete in column provided for that purpose. Job should not be noted as "Complete" before all labor as well as material is expended. If a job is complete with labor and without material, Diary should show the job and opposite it notation should be made "No material."

Material must be reported by the correct name.

Columns headed "Charge," "Price" and "Amount" should not be used by mechanics, but should be filled out in Division Engineer's office.

This book should be sent forward promptly at the end of each month.

Show where material was taken from—Stock or Storehouse. If from Storehouse, give name of same.

Enter weight or measure of articles used on the job in columns headed "Quantity," as follows:

ACCOUNT OF MATERIAL

During the month of.....190

Date.	LOCATION, NAME AND DESCRIPTION OF WORK	Completed or not Completed	CHARGE		CR.
			Acct. No.	District	Class No.
← 3/4" →	← 2 3/4" →	← 9/16" →	← 1/4" →	← 7/16" →	← 3/8" →

THREE SPACES PER INCH

USED ON EACH JOB

By.....Foreman of Bridges.

MATERIAL						
Number Articles	DESCRIPTION	Size	Quantity	Price	Amount	
← 11/16" →	← 1 7/8" →	← 3/4" →	← 9/16" →	← 3/8" →	← 7/16" →	← 7/16" →

A. B. & C. R. R. Co.

BRIDGE DEPARTMENT TOOL REPORT

(Gang or District)

Division. For ending 190

TOOLS	ON HAND 1ST	RECEIVED	SENT TO SHOP FOR REPAIRS	BROKEN OR WORN OUT	ON HAND	TOOLS	ON HAND 1ST	RECEIVED	SENT TO SHOP FOR REPAIRS	BROKEN OR WORN OUT	ON HAND
1.″5	0.″5	0.″5	0.″5	0.″5	0.″5	1.″5	0.″5	0.″5	0.″5	0.″5	0.″5

Form M. W. 1003.

A. B. & C. R. R. Co.

.....
(Gang or Dist.)

..... Division

BRIDGE DEPARTMENT TOOL REPORT

For.....Ending.....190..

Foremen are required to make the above report.....and forward same to Master Carpenter, who will, after examining, approve it and forward to Division Engineer.

To be filed in the office of Division Engineer.

SPECIFICATIONS FOR FORM M. W. 1003.

Form as here shown. Size 8x13 inches. Vertical ruling, red; horizontal ruling, blue.

Size 8 x 13 inches. Form M. W. 1004.

A. B. & C. R. R. Co.

_____ Division

STRUCTURE REPORT

The following material was used _____
(State Location of Structure definitely.)

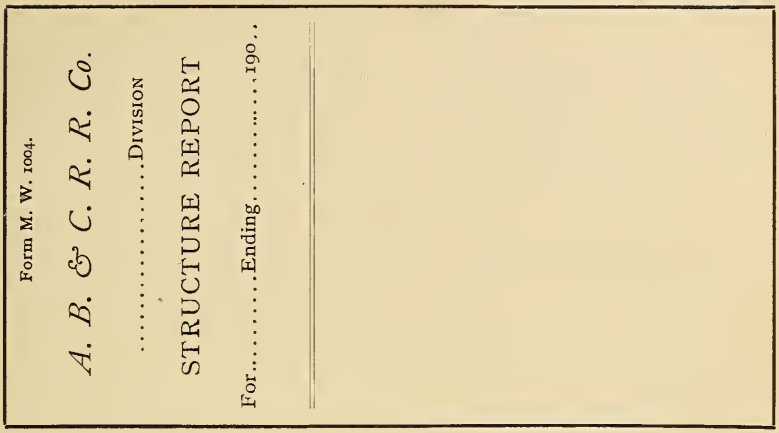
Work authorized_____ Commenced_____ Finished_____

KIND OF MATERIAL	UNIT	QUANTITY	PRICE	AMOUNT	
← 4.″2 →	← 0.″7 →	← 1.″0 →	← 0.″5 →	← 0.″8 →	← 0.″8 →
KIND OF LABOR	HOURS				
OTHER CHARGES					

THREE SPACES PER INCH

The above statement is correct:

_____
Division Engr.



SPECIFICATIONS FOR FORM M. W. 1004.

Form as here shown. Size 8x13 inches. Vertical ruling, red; horizontal ruling, blue.

Size 5¼ x 8 inches. Form M. W. 1005.

Report No.

A. B. & C. R. R. Co. Division

CURRENT BRIDGE INSPECTION REPORT

I have to-day inspected

at

and find its condition as follows:

The following work is required to maintain structure in good condition:

The following work must be done to keep the structure safe:

Inspector.

Date,——————————190

NOTE.—Make separate report for each bridge or structure inspected. Send report to the————of the Division. Report by telegraph to the———— and the Superintendent of the Division all serious defects that require attention.

SPECIFICATIONS FOR FORM M. W. 1005.

CURRENT BRIDGE INSPECTION REPORT.

Form as here shown. Size 5¼x8 inches. All letters black.

Size 8 x 13 inches

Form M. W. 1006.

*A. B. & C. R. R. Co.*_____Division.

SUMMARY CURRENT BRIDGE INSPECTION REPORT

For_____190

Bridge No. or Structure	Kind of Structure	Day of Month Insp't'd	Condition	Action taken or Recommendation

Date_____190 ____ _____

NOTE - This report to include all bridges and structures inspected during the period covered by the report.

Form M. W. 1006.

A. B. & C. R. R. Co.

.....Division

SUMMARY CURRENT

BRIDGE INSPECTION REPORT

For.....Ending.....190..

Foremen are required to make the above report.....and forward same to Master Carpenter, who will, after examining, approve it and forward to Division Engineer.

To be filed in the office of Division Engineer.

SPECIFICATIONS FOR FORM M. W. 1006.

Form as here shown. Size 8x13 inches. Vertical ruling, red; horizontal ruling, blue.

Size 11 x 8 inches. Form M. W. 1007.

A. B. & C. R. R. GENERAL BRIDGE

_____Division

From_____ To_____

Bridge No. or Structure	Location	Kind of Structure	Bridge Data	Date Inspected

SPECIFICATIONS FOR FORM M. W. 1007.

Form as here shown. Size of page, 5½x8 inches. To be issued in book form for field use, and on separate sheets for office use. Vertical ruling, red; horizontal, blue.

INSPECTION REPORT.

For_____

Inspected by_____190

General Condition, Description of work required, Recommendations.

*FORMS FOR "GENERAL LABOR REPORT," "MONTHLY TRACK MATERIAL REPORT," "RIGHT-OF-WAY MAPS," "REGISTER OF TITLE DEEDS," AND "CONTRACT AND LEASE RECORD BOOK."

RECOMMENDED STANDARD FORMS.

The "General Labor Report" or "Time Book" form, M. W. 1008, is recommended as a standard form for use by all employés or working gangs in a Maintenance of Way and Structure Department.

The "Monthly Track Material Report" form, M. W. 1009, containing the necessary information for keeping a proper check on material received and used, is recommended as a standard form.

Right-of-Way Maps should be prepared and kept in general in accordance with form M. W. 1010, which is recommended as a standard form for Right-of-Way Maps.

The custodian of deeds should keep a "Register of Title Deeds" in accordance with form M. W. 1011, which is recommended as a standard form for "Register of Title Deeds."

The custodian of leases should keep a "Contract and Lease Record Book" in accordance with form M. W. 1012, which is recommended as a standard form for a "Contract and Lease Record Book."

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*Adopted, Vol. 6, 1905, pp. 624-655, 657-660, 668-673.

Form M. W. 1008.

A. B. & C. R. R. CO.

.....*Division.*

TIME BOOK

—OF—

Section No......

.....*Foreman.*

Headquarters.....

Month of.....*190*.....

SPECIFICATIONS FOR FORM M. W. 1008.

Size of book, 5x8 inches. Form as shown, cover to be of three-ply manila paper; book proper to be on yellow paper; printing to be in black. Book to contain 12 pages. (Form shown is about one-half reduction.)

(Inside cover page.)

INSTRUCTIONS.

1. Enter the information daily.
2. Read the instructions at the bottom of pages 2 and 3.
3. Show under each day the hours of work of each kind done, including work done by Foreman.
4. The Summary on pages 14 and 15 must show all the work done during the month. It is obtained by collecting the work done each day. Show separately work done on main tracks, sidings, new or construction work of all kinds. and for individuals or other companies.
5. The total hours each day must agree with the totals shown on pages 2, 3, 4, 5, 6 and 7.
6. The total of hours in Summary must agree with the total on page 7.

DAILY RECORD OF TIME FOR

NAME	CHECK No.	OCCUPATION	1	2	3	4	5	6	7	8	9	10	11	12	13
TOTAL,															

1. Spell names correctly. Write out first name and give middle initial. Enter check number in check number column.
2. Write "Paid by Certificate," when men have been so paid. If hired again, enter name a second time.

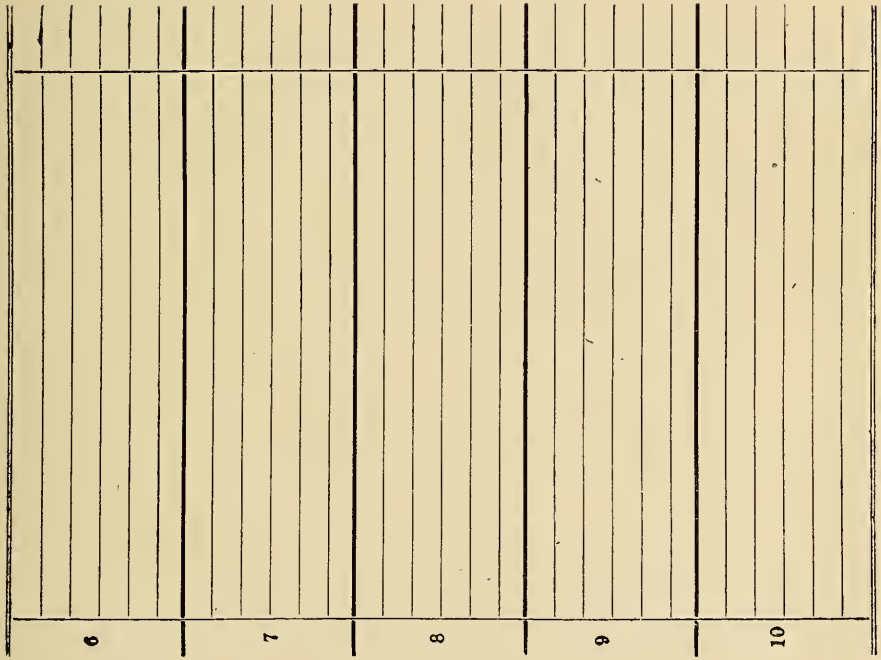
MONTH OF_____190

14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	TOTAL HOURS.	RATE OF PAY. PER MONTH.	RATE OF PAY. PER HOUR.	AMOUNT.	

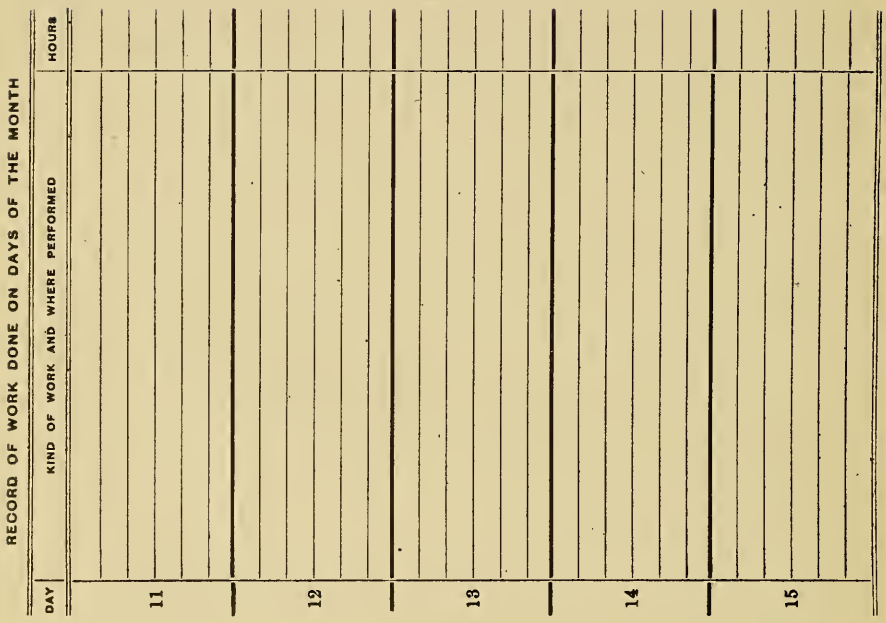
3. Amounts due each man must be in even five (5), or ten (10) cents.
4. Time of monthly men, not working a full month: Multiply the rate per month by the number of days worked (including Sundays and holidays), and divide by the total number of days in the month.

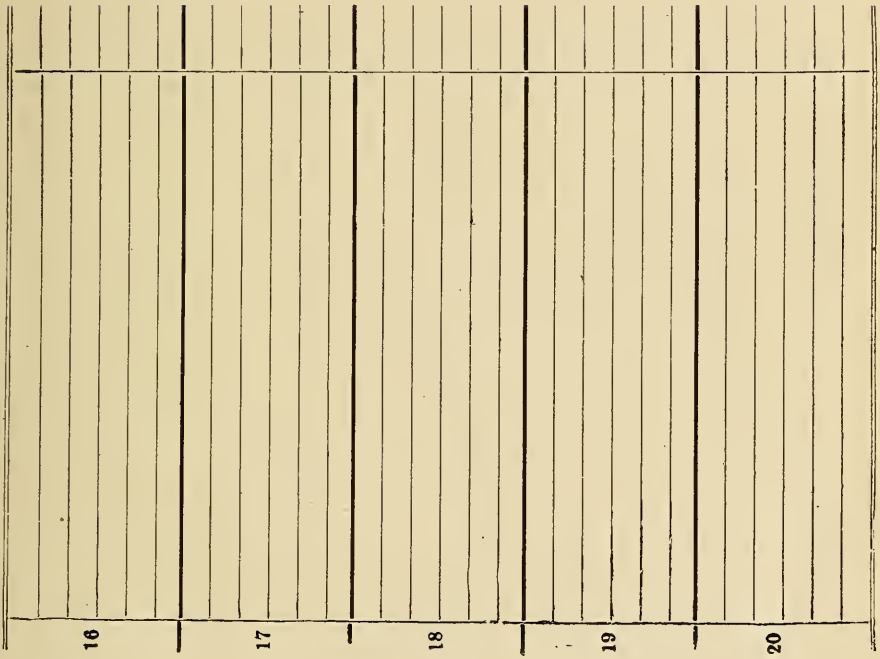
RECORD OF WORK DONE ON DAYS OF THE MONTH

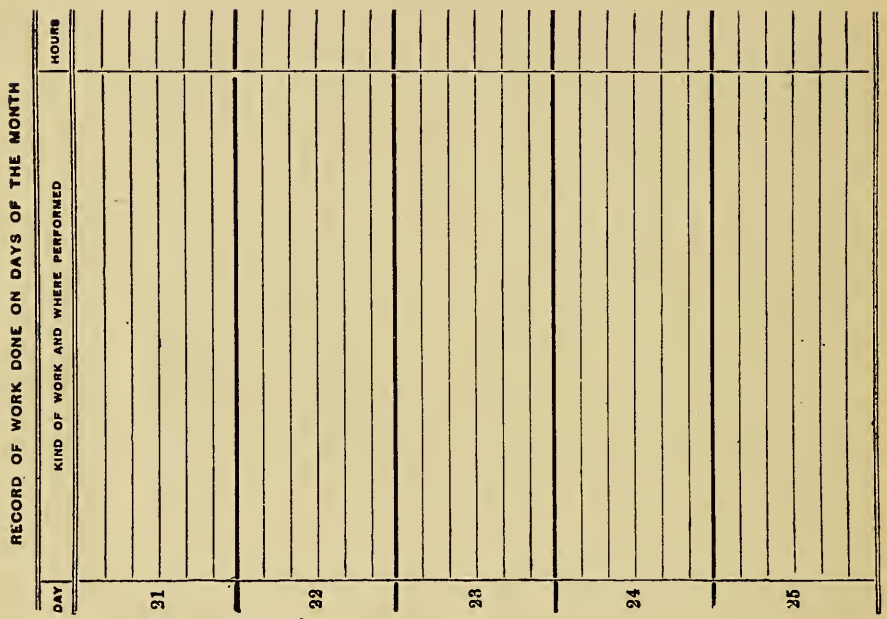
DAY	KIND OF WORK AND WHERE PERFORMED	HOURS
1		
2		
3		
4		
5		

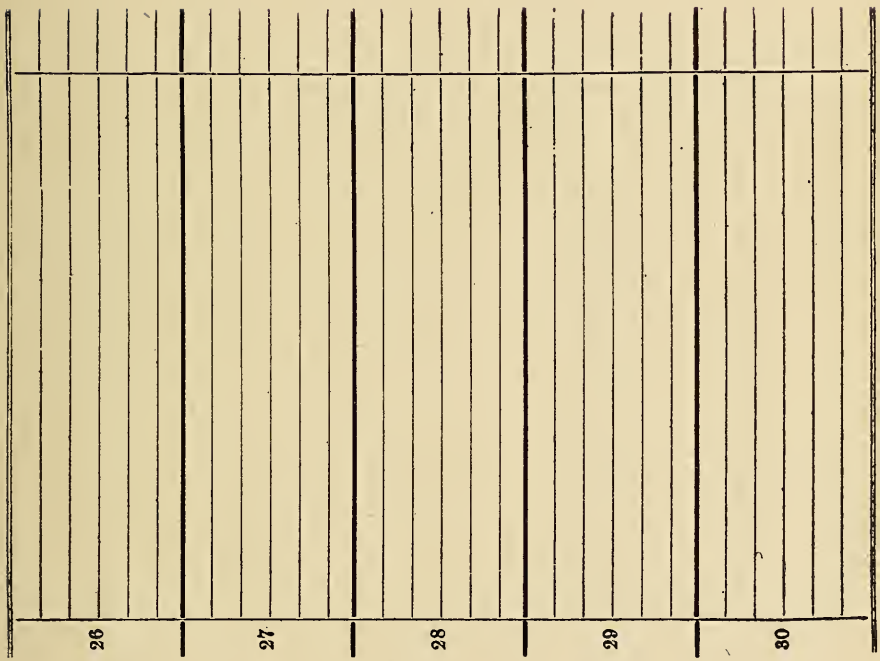


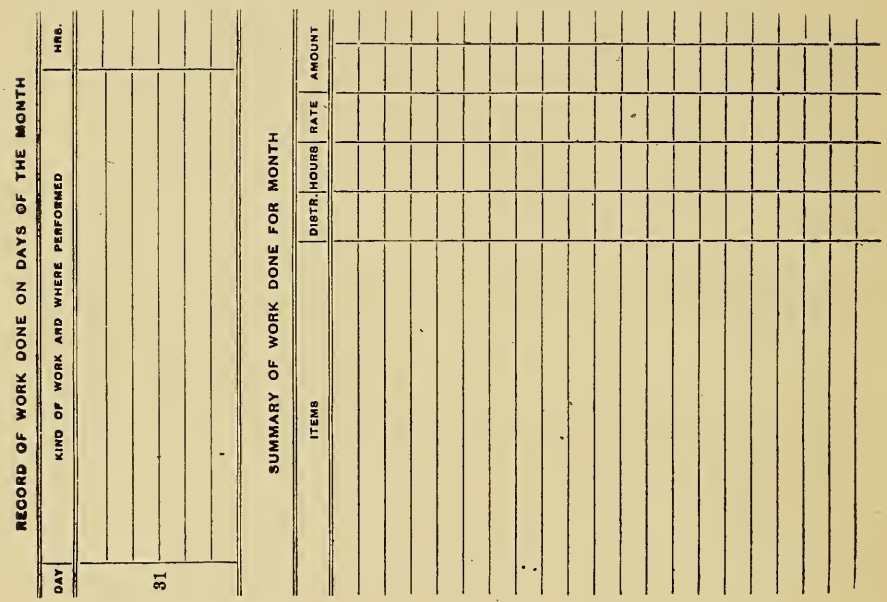
5


RECORD OF WORK DONE ON DAYS OF THE MONTH
DAY
KIND OF WORK AND WHERE PERFORMED
HOURS
11
12
13
14
15


16
17
18
19
20


RECORD OF WORK DONE ON DAYS OF THE MONTH
DAY
KIND OF WORK AND WHERE PERFORMED
HOURS
21
22
23
24
25


26
27
28
29
30


RECORD OF WORK DONE ON DAYS OF THE MONTH
DAY
KIND OF WORK AND WHERE PERFORMED
HRS.
31
SUMMARY OF WORK DONE FOR MONTH
ITEMS
DISTR.
HOURS
RATE
AMOUNT

I certify the foregoing to be correct.

_____ *Foreman.*

Examined and approved,

_____ *Superintendent.*

A. B. & C. R. R. Co.

RIGHT-OF-WAY MAPS.

365
HENRICI & DUSS, TRUSTEES,
TO
P. & L. E. R. R.,
BEAVER FALLS, BEAVER CO.
W. DEED.
Feb. 6, 1892. Rec. 142-398.
Con. $2,100. Slopes, None.

DESCRIPTION.

Lot 22, 23, 24, b'd n by lots of Darragh, Fetterman and Porter, e by Lincoln alley, s by 17th st, w by 2d ave.

Conditions, None.

366
J. S. DARRAGH ET AL,
TO
P. & L. E. R. R.,
BEAVER FALLS, BEAVER CO.
CON. PRO.
No. 271, June, 1883.
Con., $4,309.28. Slopes, None.

DESCRIPTION.

60 ft. wide through property. Plot shows 30 ft. each side of C. L. from Economy addition to Henrici and Lenz. Being grantors 13-24 undivided interest in same.

Conditions, None.

367
H. W. HARTMAN
TO
P. & L. E. R. R.,
BEAVER FALLS, BEAVER CO.
R. OF W. DEED.
July 10, 1889. Rec. 122-106.
Con., $8,000. Slopes, 2d P., yes.

DESCRIPTION.

First Par.—B'd s by Harmony Society, e by Beaver River, n by Mrs. Metzgar, w by a line 30 ft. and part with N. B. C. L. and in addition so much as shall be necessary for R. of W. for siding to Paper Mill.

Second Par.—60 ft. wide from Paper Mill on s to Harmony Society on n, as shown by plot (no plot attached). Being grantors int. in above parcels.

Conditions.

Not to interfere with dam, right to transmit power under tracks, water wheels, two road crossings, to enlarge culvert, access to dam to repair same, 10 ft. to be reserved by grantee for siding above dam and w of track. Not to extend slopes into river, release of old R. of W. interest of Jas. Darragh.

368.
JAMES DARRAGH
TO
J. M. SCHOONMAKER,
BEAVER FALLS, BEAVER CO.
W. DEED.
Oct. 4, 1894. Rec. 147-233.
Con., $4,500. Slopes, None.

DESCRIPTION.

First Par.—Water lot 6, B'd n by lot 5, e by Beaver River, s by lot 7, w by R. of W. 120 ft. wide, extending to river.

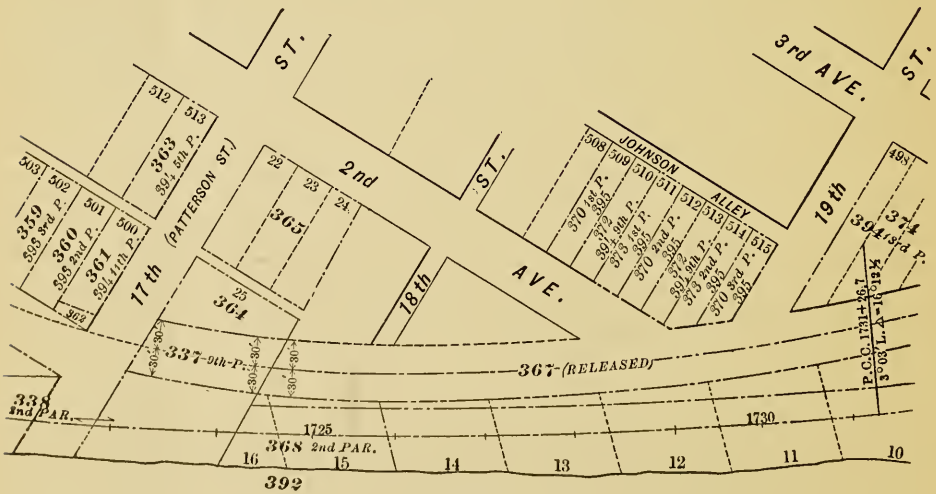
Second Par.—Water lots 15 and 16, B'd n by lot 14, e by Beaver River, s by line of Economy plan, w by R. of W.

Third Par.—Lots 543, 544, 545, B'd n by unnumbered lot, e by Beaver River, s by lot 542, having a front on R. of W. of 1,845 ft.

Fourth Par.—Lots 546, 547, B'd n by lot 548, e by river, s by unnumbered lot, w by R. of W., 123 ft.

Fifth Par.—Unnumbered lot, B'd n by lot 546, e by river, s by lot 545, w by R. of W., 61.5 ft.

Conditions, None.



Form M. W. 1009.

A. B. & C. R. R. Co.

MONTHLY TRACK MATERIAL REPORT.

Subdivision_____ Section No._____ For Month Ending_____ 190____

Column Nos. → 1	2	3	4	5	6	7	8	9	10	11	12	13	14
Description of Material	Unit	On Hand at date of last Report	Received during the Month: By Shipment	Taken Out of Track	From Track Taken up	Total to Account for	Used and Shipped during the Month: Repairs Main Track	Repairs Sidings	New Tracks		Shipped Away	Total Disposed of	On Hand at date of this Report
Rail—new—1st. Class_____ lbs. per yard.	Feet												
" " " " " " " "	"												
" " 2nd. Class_____ " " "	"												
" " " " " " " "	"												
Rail—relaying— " " "	"												
" " " " " "	"												
" " " " " "	"												
	"												
Scrap Rail—lengths 6ft. and over—lbs. per yard.	"												
" " " " " " " " " "	"												
" " " under 6 ft. " " "	"												
Scrap—Frog—Switch and Guard Rails	"												
Scrap—Miscellaneous track	Pounds												
Cross Ties—1st. Class	Number												
" " " "	"												
" " 2nd. Class	"												
" " " "	"												
Switch Ties—turnout and Crossover—(Fill out space on back.)	Lin'r feet												
Bolts—Track—	Kegs												
" "	"												
R. R. Spikes.	"												
" "	"												
Tie Plates— # Intermediate No.____ Joint, No.____	Number												
" " # " " " " " "	"												
" " # " " " " " "	"												
Nut Locks— diameter of hole	"												
" " " " "	"												
Rail Braces #	"												
" " #	"												
" " #	"												
Tie Plugs—	"												
	"												
Angle Bars— weight____ drilling____	Pairs												
" " " " " "	"												
" " " " " "	"												
" " " " " "	"												
" " " " " "	"												
" " " " " "	"												
" " " " " "	"												
Angle Bars—Offset—from____ to____	"												
" " " " " "	"												
" " " " " "	"												
Angle Bars—Insulated—weight—# drilling____	"												
" " " " # "	"												
" " " " # "	"												
" " " " # "	"												
Fibre End Posts—weight—	Number												
" " " "	"												
Frogs (Analysis of balance on hand at end of month) — Kind / No. / Weight / New or Old / R.H. or L.H.	"												
	Number												
	"												
	"												
	"												
Switches (Complete) — Kind / Length / Weight / New or Old	"												
	"												
	"												
	"												
Extra Switch Points	"												
	"												
	"												
	"												
Slip Switches—weight____ No.____	"												
Guard Rails " ____	"												
" " " ____	"												
" " " ____	"												
Switch Rods—Insulated	"												
" " Plain.	"												
Slide Plates—with braces—weight____ #	"												
" " " " " ____ #	"												
" " plain " ____ #	"												
" " " " ____ #	"												
Switch Stands—Name____ High or Low____	"												
" " " " " "	"												
" " " " " "	"												
Switch Latches	"												
Switch Locks—	"												
Frog and Crossing Bolts.	"												
R. R. Crossings—for Crossing____ weight____ #	"												
Switch Lamps	"												
Signal Lamps	"												
Crossing Plank	Lin'r feet												
Crossing Spikes	Pounds												
Salt	Barrels												
Oil—Headlight	Gallons												
" Signal	"												
" Lubricating	"												
Waste	Pounds												
Pipe—Terra Cotta—size	Lin'r feet												
" " " "	"												
Iron Pipe "	"												
Fence Posts	Number												
Fence Boards.	Ft. B.M.												
Wire Fencing.	Rods												
Cattle Guards—Iron____ Wood____	Number												
	"												
	"												

Checked and found correct

Supervisor of Track.

The above account is correct

Section Foreman.

SPECIFICATIONS—Size 14"x17." Form as shown. Ruling: Horizontal—single lines, blue; parallel lines, red; vertical—black or blue.

REMARKS:

Form M. W. 1009.

A. B. & C. R. R.

.....Division.

MONTHLY TRACK MATERIAL REPORT.

Section No.....

Month of.....19....

INSTRUCTIONS.

1. The Section Foreman must keep in a small blank book a daily record of all materials used.
2. He must also keep in the space provided on the back of this blank a daily record of all materials received and shipped.
3. He must close his account on the .....th of each month, and forward the report so as to reach the Supervisor not later than the morning of the .....th of each month.
4. Column No. 14 must show the material actually on hand on the day the report is made
5. The Supervisor must check the report, sign it and send it to the Division Engineer so as to reach him on the morning of the .....th.

TO BE FILED IN OFFICE OF DIVISION ENGINEER.

Daily Record of Material "Received by Shipment" and "Shipped Away"

Material Received				Material Shipped Away			
Date	Quantity	Description	From Whom Received	Date	Quantity	Description	To Whom Shipped

SPECIFICATIONS FOR FORM M. W. 1010.

RIGHT-OF-WAY MAPS.

Maps showing right-of-way in cities and boroughs should be drawn to a scale of 100 ft. to 1 in. Maps showing right-of-way outside of municipalities may be drawn to a scale of 400 ft. to 1 in. They should be prepared, generally, as shown in the illustration. They should be made in separate sheets for convenient handling, and the width of sheets as a rule should not exceed 18 in. The length of sheets will be determined generally by the size of the printing frame.

Right-of-way sheets may be preserved in one of three ways:

(1) The sheets may be bound together into an atlas.

(2) They may be bound loosely in board covers, so that the sheets may be easily removed and corrected and replaced.

(3) They may be preserved as separate sheets and filed in regular order.

A. B. & C. R. R. Co.

Form M. W. 1011.

MAIN LINE. REGISTER OF TITLE DEEDS. WAYNE COUNTY, MICHIGAN.

No.	Township.	City.	Sub-Div'n.	Sec.	Town'p	Range.	Block.	Lots.	Description.	Grantor.	Grantee.	Date of Conveyance. M. D. Y.	Consideration	Length	Width.	Area.	Recorded. B'k	Page.	Date. M. D. Y.	Kind of Deed	Conditions.
41	.....	Detroit	.....	..	..	....		16, 17,18	N. E. Cor. 4th and Front	Catherine H. Jones.	M. C. R. R.	Apr. 16, '47.	$2,300	97.48	60	1.34	31	274 275	Sept. 14,'47.	W.	None.
43	.....	"	.....	..	..	....	H	25-26	North of Front....	J. Halbert and Wife	"	Mar. 5, '47.	600	86.44	40	.79	31	273 274	" " "	W.	"
55	.....	"	.....	..	..	....	K	1-2	S. W. Cor. 4th and Front	Lewis Cass and Wife	"	Sept. 8, '47	19,000	.....	.....	.46	31	278 280	" " "	W.	"
40	Springwells.	"	.....	..	..	....	..	Water Lot 2, 3	Bounded E.'ly by Canal Bank, W. Ann Hunt, N. Woodbridge St., S. by channel....	J. Mullet and Wife	"	Apr. 16, '47,	5,200	400	169.5	1.55	30	112 113 114	Apr. 20, '47.	W.	.....
255	"	"	.....	..	..	....	..	.....	Triangular piece S. E. Cor. 12th and Woodbridge St.....	M. C. R. R.	Fort St. Union D.	Dec. 29, '90.	2,900	250	2.25	....	....	.....	.....	C.	.....
8	"	"	.....	..	..	....	..	.....	Bounded W.'ly by Henry Stanton, E.'ly by Peter Godfrey	Farm'r and Mech Bank J. A. Wells and Wife	M. C. R. R.	Jan. 21, '47.	200	820	140	2.63	29	338-9 340	Jan. 21, '47.	W.	Fences, crossing. gates, etc.
250	"	"	Clarks.	..	..	....	..	120	S. ½ of E. ½ of E, ½ of P. C. 77.....	H. Warren and Wife	"	Apr. 30, '02.	1.00	.....	.....	.063	569	292	May 10, '02.	Q.C	.....
106	Dearborn....	.....	.....	29	2s	10 E	..	.....	W. ½ of N. E. ¼ ..	A.Clay and Wife.....	"	June 1, '72.	75.00	1350	20	0.62	162	270	June 3, '73.	W.	.....
12	Nankin.....	.....	.....	31	2s	9E	..	.....	W. ½ of S. E. ¼...	C.W. Brink	St.of Mich.	Mar. 3, '41.	1.00	205	100	0.47	20	595-6			R. R. Purposes.
70	"	.....	.....	31	2s	9E	..	.....	W. ½ of S. W. ¼ ..	Wm. Bell and Wife	M. C. R. R.	Feb. 25, '48.	1.00	1470	100	3.37	32	563	Mar. 3, '43. Mar. 29, '48.	W. W.	.....
33	VanBuren...	.....	.....	5	3s	8E	..	.....	E. ½ of N. W. ¼..	B. Cotton and Wife	"	Jan. 8, '47.	1.00	1270	100	2.92	A	504	Jan. 13, '47.	W.	.....
94	Canton	.....	.....	35	2s	8 E	..	.....	N. of and adj. Rt. of Way in S.W. ¼	L. Sterling and Wife	"	Jan. 10, '59.	1.00	490	228	2.45	76	360	Jan. 22, '59.	W.	R. R. Purposes.

SPECIFICATIONS FOR FORM M. W. 1011.

REGISTER OF TITLE DEEDS.

Form as shown; size of page, 12x28 in.; to be in book form, on heavy white ruled paper; horizontal ruling to be blue; vertical ruling to be red. (Form shown is two-thirds reduction.)

Deeds are filed with the Chief Engineer, the Real Estate Agent, or the Secretary of a railroad company, according to individual practice.

The custodian of deeds should keep a Register of Title Deeds, in accordance with the form illustrated.

Deeds should be numbered consecutively, No. 1, 2, 3, etc., in the order of their receipt by the railroad company; then forwarded to the proper officer to record on right-of-way maps; then returned by the Chief Engineer to the custodian of deeds with notation thereon that the deed has been properly entered, after which all deeds should be filed in numerical order in a fireproof vault.

CONTRACT AND LEASE RECORD. Form M. W. 1012.

A. B. & C. R. R. CONTRACTS AND LEASES

100 Pages

Number	Name of Road	With Whom	Nature of Document		Date	Expires	No. of Canceled Contract	Memoranda

RECEIPTS FOR CONTRACTS AND LEASES REMOVED FROM FILES.

RECEIPTS FOR CONTRACTS AND LEASES REMOVED FROM FILES.

60 Pages

Number	Name of Road	With Whom	Receipt	When taken	When returned	Number	Name of Road	With Whom	Receipt	When taken	When returned

REFERENCES TO CONTRACTS AND LEASES, SHOWING DATE OF EXPIRATION

REFERENCES TO CONTRACTS AND LEASES, SHOWING DATE OF EXPIRATION

8 Pages

JANUARY																	FEBRUARY															
1897	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913		1897	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913

SPECIFICATIONS FOR FORM M. W. 1012.

CONTRACT AND LEASE RECORD.

The custodian of leases should keep a Contract and Lease Record Book, containing in the body of the book a full record of the lease in accordance with the form illustrated.

In the back part of the book twelve pages for the twelve months should be ruled into columns for years.

Leases should be numbered and filed in numerical order, by road, branch or division, in a fireproof vault.

Immediately after the receipt of a lease it is entered in the body of the book; the lease number should be entered under the year on the proper month page when it expires.

The names of the lessees should be indexed alphabetically in the front of the book, and each lease should be indexed by the station name.

A few pages in the back of the book should be used for the purpose of keeping a record of the leases removed from the files.

*LEDGER ACCOUNTS WITH INDIVIDUAL PIECES OF WORK.

CONCLUSIONS AND RECOMMENDED STANDARD FORMS.

Ledger Accounts with Individual Pieces of Work, showing the detail, total, comparative and unit costs of work are essential in any system, according to which statements and appropriations must be made before work involving Additions and Betterments can be undertaken; therefore Ledger accounts should be kept by the Maintenance of Way Department showing the cost of authorized work.

†SYSTEM FOR MAINTENANCE OF WAY OFFICE RECORDS OF STRUCTURES.

RECOMMENDED PRINCIPLES OF PRACTICE.

No special forms are required in a proper system of Maintenance of Way Office Records of the design of bridges and culverts. Such records should be kept in accordance with the following system:

(a) The Chief Engineer, or other officer having in charge the design and care of structures, should keep on file in his office complete plans of every structure, showing all its details, its location and the physical characteristics of the territory within a reasonable distance of the structure.

(b) When changes in the design of any structure are made, a record of the changes should be reported to the head office and the record plans should be at once brought up to date.

(c) Division officers having in charge the maintenance of bridges should keep on file in their offices blue prints of the general and detail plans of all structures, and these prints should be furnished from the office of the Chief Engineer or other officer in charge of the designs.

(d) Photographs of the record tracings of bridges should be prepared and furnished to division or other officers for use in the field. These photographic copies should be of standard sizes and kept in atlas form.

(e) The record of the condition of bridges should be kept in accordance with the system indicated by the recommended forms M. W. 1005, 1006 and 1007.

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* Adopted, Vol. 7, 1906, pp. 279, 318-327.
† Adopted, Vol. 7, 1906, pp. 279, 280, 327, 328.

FORM M. W. 1015.

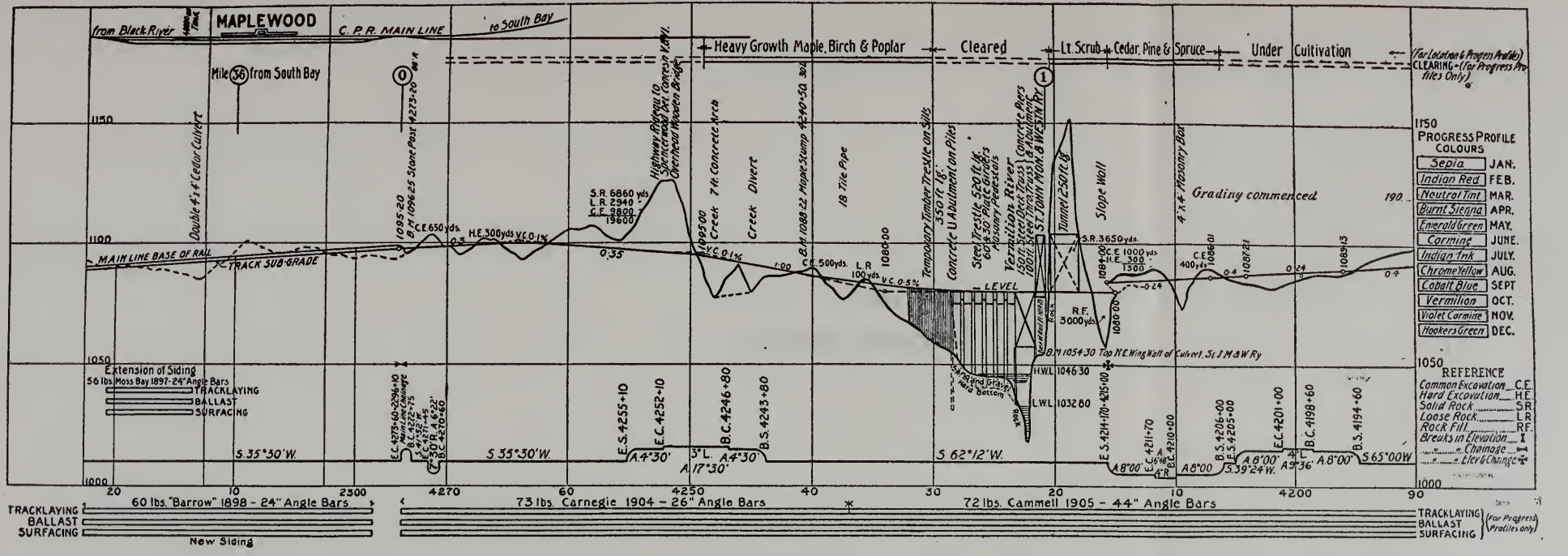
PROGRESS PROFILE.

FORM M. W. 1016.

TRACK CHART.

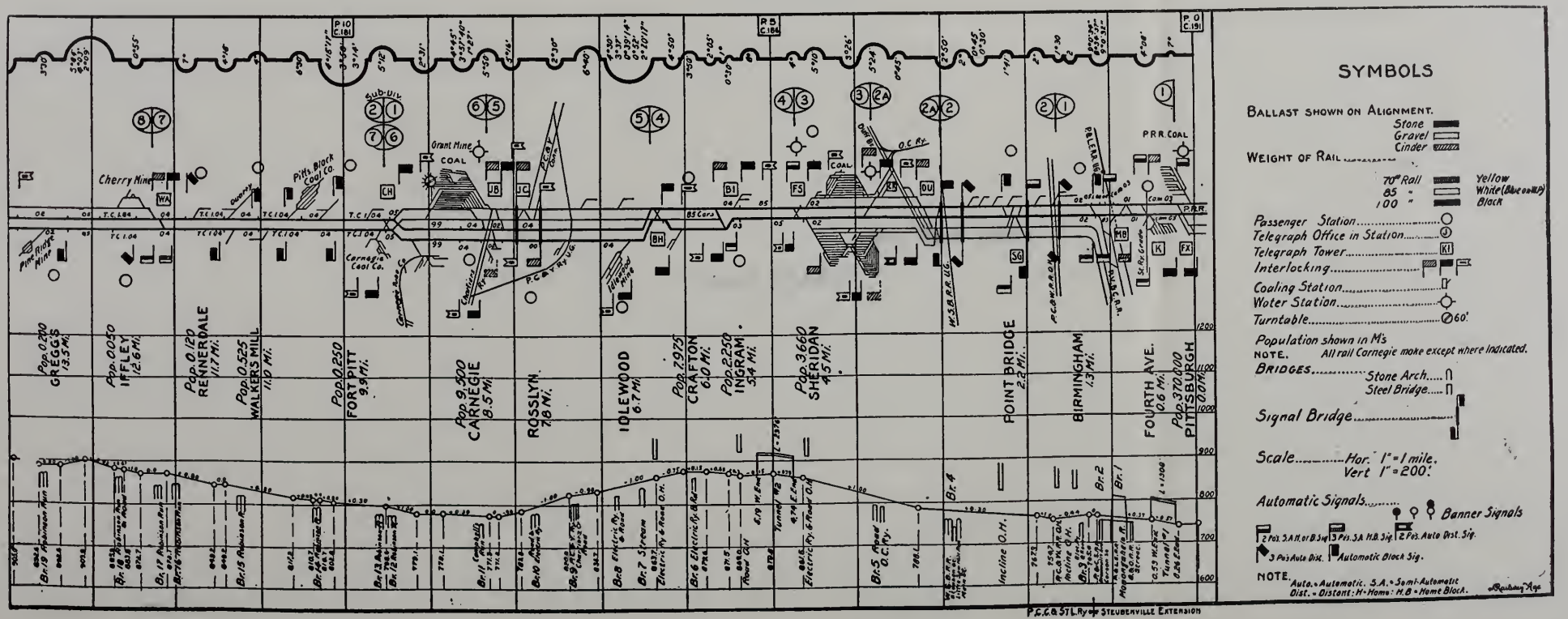
PROGRESS PROFILE.

Form M W. 1015



TRACK CHART.

Form M. W. 1016



*PROGRESS PROFILES.

CONCLUSION AND RECOMMENDED STANDARD FORM.

A profile showing complete information respecting the rate of progress of work pertaining to the different features of a railroad is necessary, and the standard "Progress Profile," form M. W. 1015, is recommended as good practice.

†TRACK CHART.

CONCLUSION AND RECOMMENDED STANDARD FORM.

A Track Chart showing complete information respecting the grade, alinement and other physical features of a railroad is necessary, and the "Track Chart," form M. W. 1016, is recommended as good practice (except the conventional signs shown on the chart).

‡AUTHORITY FOR EXPENDITURE.

CONCLUSION AND RECOMMENDED STANDARD FORMS.

Construction, addition or betterment work should be authorized in accordance with a reasonable and simple system, involving the preparation of estimates of cost and the formal authorization of the expense by executive officers, and forms M. W. 1017, M. W. 1018 and M. W. 1019 are recommended as representing good practice.

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* Adopted, Vol. 7, 1906, pp. 278, 280, 328, 329.

† Adopted, Vol. 7, 1906, pp. 278, 280, 328, 329.

‡ Adopted, Vol. 8, 1907, pp. 111, 112, 114, 116-120, 132. These forms, M. W. 1017, 1018 and 1019, take the place of forms 1013 and 1014.

Note.—Forms M. W. 1013 and 1014 withdrawn by vote of convention, Vol. 8, 1907, p. 135.

Size 8x13 inches. Front of Blank. Form M. W. 1017.

ESTIMATE FORM.

ESTIMATE NO._____

. . A. B. & C. R. R. Co.

Division_____

ESTIMATE based on plan No._____ Dated_____

_____

_____

_____

_____

_____

LOCATION _____

GRAND TOTAL_____

CREDITS TOTAL CREDIT_____

NET_____

DISTRIBUTION OF EXPENSE

	Road or Division.	Road or Division.	Road or Division.	Total
New Work (for Additions)				
Betterment				
Renewals or Replacements				
Individuals and Companies. (Give dates of agreements, names of parties against whom bills are to be made, amount chargeable to each, and indicate by * items in above estimate that are to be billed.)_____				
_____				
_____				
_____				

Correct. The above expenditure is respectfully recommended. Approved.

_____ (Title) _____ (Title) _____ (Title)

Date_____ Date_____ Date_____

COST OF REPLACING EXISTING BUILDINGS OR OTHER STRUCTURES.

Description.		Disposition.

INSTRUCTIONS FOR USING THIS BLANK.

(1) When estimate is based upon plans, always refer to numbers and dates of plans.

2) Observe the following rules in describing work:

(a) When additional buildings or other structures are to be built, begin your description with the word "New."

(b) When a building or other structure is to be built to replace an inferior one, or one of different kind, begin your description with the word "Replacing."

(c) In case of replacement, mention should be made of any variation from the original construction, such as:

Substituting stone for frame building.
Steel for wooden bridge, etc.

(d) When a building or other structure is reconstructed, restoring the original, use the word "Renewing."

(e) Under other conditions use a suitable word, such as:

Strengthening (Bridges).
Changing (Yard Tracks).
Altering (Buildings).
Extending or Widening (Wharves).
Improvement at (Consisting of new standard 20x40 foot frame passenger station, renewing 30x50 foot standard frame freight station, altering yard tracks, strengthening bridge $500, etc.).

(3) CREDITS: When including in the estimate material which is to be used in temporary work, allow (under head of "Credits") an amount to cover estimated value of material to be recovered.

(4) When the plan provides for replacing inferior buildings or other structures with buildings or other structures of a superior kind, always give on back of blank, in the space provided, the estimated cost of reproducing the existing buildings, or other structures, based on current market prices.

Give estimate for each building or other structure separately.

(5) On back of blank, in "Disposition" space, show disposition to be made of the abandoned buildings or other structures.

6) DISTRIBUTION: When more than one road or division is affected, divide cost on a land ownership basis, unless otherwise instructed.

All new work can be shown as a charge to New Work or Additions.

Replacement work can be divided on the basis of charging to Replacements or Renewals the cost to reproduce the existing building or other structure, based on current market prices. The excess or difference between estimated cost and reproduction cost should be shown under "Betterments."

Individuals and Companies. (See instructions on face of blank.)

(7) This form to be submitted in triplicate by the originating officer to the approving officer. (Estimates should be submitted as per special instructions of individual roads.) If estimate is approved, authority for performing work will be given on Form No. 1018.

(8) Number the estimates consecutively, beginning with No. 1. Revised estimates should be given a new number.

Size 8x10½ inches. AUTHORITY FORM. Form M. W. 1018

A. B. & C. R. R. Co.

_____ 19____

(Title of approving officer.)

....Estimate No..... Dated.....190...

CHARGE TO
Construction .....
Additions .....
Replacements or Renewals .....
Special .....
Individuals and Companies .....
.....
.....

CHARGE APPROVED:
In all Vouchers, Reports, etc., refer to
AUTHORIZATION No.....

This authority to be supplemented by Form 1019 at the discretion of the approving officer.

The expenditures under this authority must not exceed the amount authorized. Additional authority must be obtained in case of necessity.

This authority expires at the end of the year in which issued. If work is incomplete at that time, a new authority will be issued for the following year's expenditures.

Size 8x10½ inches. APPROPRIATION FORM. Form M. W. 1019.

A. B. & C. R. R. Co.

_____ 19____

.....Estimate No..... Dated.....19....

CHARGE TO

Construction.....

Additions.....

Replacements or Renewals.....

Special.....

Individuals and Companies.....

.....

.....

CHARGE APPROVED:

In all Vouchers, Reports, etc., refer to

AUTHORIZATION No.....

The expenditures under this authority must not exceed the amount authorized. Additional authority must be obtained in case of necessity.

This authority expires at the end of the year in which issued. If work is incomplete at that time, a new authority will be issued for the following year's expenditures.

SPECIFICATIONS AND INSTRUCTIONS FOR USE OF FORMS

M. W. 1017, 1018 and 1019.

Form M. W. 1017, size 8"x13½", to be printed on medium bond paper (white), should be used for submitting estimate of cost of work to the officer who issues the authority (form 1018) for doing the work. This form, when properly filled out, should show:

(1) A reference to the plan number.
(2) A brief and concise description and location of the work covered by the estimate.
(3) Estimate of cost in detail.
(4) Credits, if any, for material to be recovered, etc., such as salvage from false-work, temporary tracks, and in case of a renewal (which renewal is occasioned on account of a fire) the amount of insurance recovered, and anything else that is a proper credit to the job.
(5) Distribution of estimated cost as between New Work, Betterments, Renewals or Replacements and Individuals and Companies.
(6) Estimate will be signed by various officers in accordance with the prevailing organization.
(7) Reproduction cost of any building or other structure which is to be replaced. This information will be required by the officer determining the distribution of the expense.

A set of instructions governing the use of the form has been provided. Special attention is called to those covering the describing of work.

Form M. W. 1018, size 8"x10½", to be printed on medium bond paper (yellow). Yellow paper is recommended so as to make this form distinctive.

This form should be used by the highest executive officer to convey to those interested the fact that the work is authorized and the estimate approved. This form, when properly filled out, should show:

(1) A brief and concise description and location of the work.
(2) Estimated cost, in a lump sum, which lump sum will be the total of the estimate, or estimates, as given on form 1017.
(3) Instructions as to whether form 1019 is to be submitted or not.
(4) A reference to the number, or numbers, of estimates (form 1017) which it covers, and an approved copy of the estimate (form 1017) should be attached to each copy of form 1018, issued for the information of all concerned.
(5) Distribution of expense as between Construction, Additions, Replacements, Special and Individuals and Companies.

This form does not authorize expenditures of money unless it bears a notation that form 1019 will not be required. The actual expenditures of money would be authorized on form 1019, except as above noted.

Form M. W. 1019, size 8"x10½", to be printed on medium bond paper (white), should be used by the proper officer to authorize expenditures of money for work authorized by form 1018.

This form, when properly filled out, should show:

(1) A brief and concise description and location of the work to be done.
(2) Total amount of form 1018, of which it is a part.
(3) The Engineer's estimate as covered in form 1018.
(4) A detailed or lump sum amount required for the job.
(5) Distribution of the expense.
(6) Number of the form 1018 against which it applies. A designating letter in addition to the number.
(7) And any other detail required by the company or approving officer.

Note.—For the general outline and description of method of using these blanks see Vol. 8, 1907, pp. 109-111.

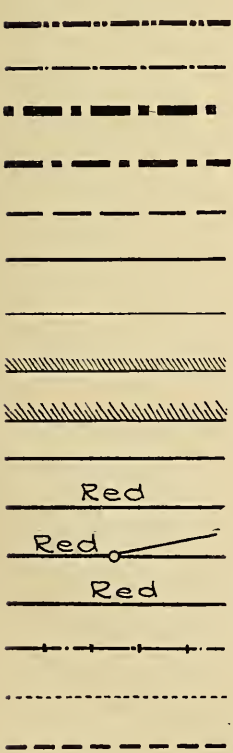
*CONVENTIONAL SIGNS.

CONCLUSION AND RECOMMENDED PRACTICE.

Standard Conventional Signs for use on right-of-way, topographical and other maps are desirable in railroad work, and the Conventional Signs illustrated on forms M. W. 1020, M. W. 1021 and M. W. 1022 are recommended as good practice.

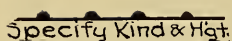
GROUP I.

Form M. W. 1020.

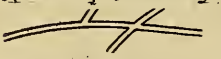


Right-of-way Lines.
Property Lines—Foreign.
State Lines.
County Lines.
Township Lines.
Section Lines.
Interior Section Lines.
City Limits.
Fire Limits.
Street or Block Lines.
Survey Lines.
Preliminary Survey.
Location Survey.
Monumented Center Lines.
Original Center Lines.
U. S. Harbor Lines.

* Adopted, Vol. 8, 1907, pp. 114, 121-125, 134.



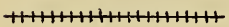
Fences.


Roads.

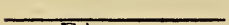
Private and Secondary Roads.

Trails.

Railroads under Construction.

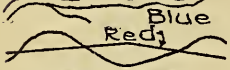

Railroads.

Street Railroads.



Canals.

Streams.

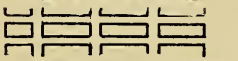


Surface and Grade Lines.

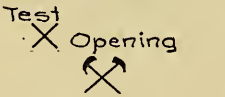
Contours.

North Point.

Buildings and Villages.

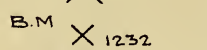

Cities and Towns.

Coal Outcrop.



Test Opening.

Mine in Operation.

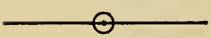


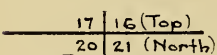
Bench Mark.

Shaft.

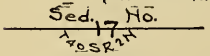
Triangulation Station.

Mine Tunnels.

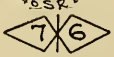

Property Corners and Survey Station.



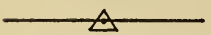
Section Corner.

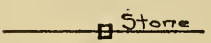


Section Center.

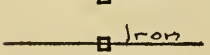


Construction Section Lines.


Transit Point.



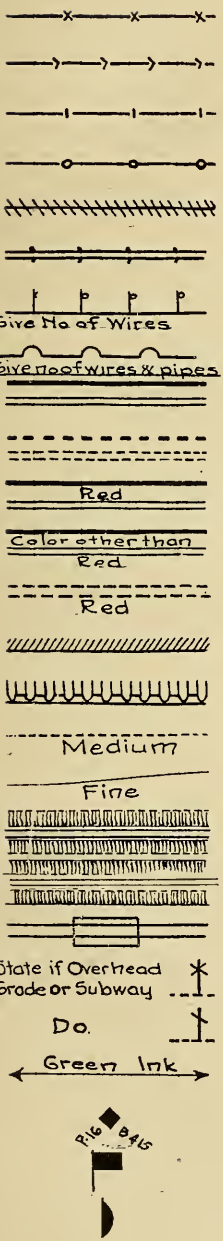
Stone Monument.



Iron Monument.

CONVENTIONAL SIGNS—GROUP 2.

Form M. W. 1021.



Common Water Pipe.

Other Water Pipe.

Steam Pipe.

Compressed Air Pipe.

Pintsch Gas Pipe.

Sewer Pipe.

Telegraph Line.

Signal Line.

Old Tracks to Remain.

Old Tracks to be Moved.

New Tracks.

Foreign Tracks.

Future Tracks.

Abutments, Walls, Etc.

Cribbing.

Bottom of Slope.

Top of Slope.

Embankments.

Cuts.

Road Crossings.

Public Crossings.

Private Crossings.

Dimension Lines.

Mile Post.

Block Signal.

Yard Limits.

Water Column.
Frog and Head Block.
Track Scales.
Water Station.
80
Turntable.
Interlocking Tower.
O.T.P.
Telegraph Pole.
W C.
Water Closet.
Watch Box.
Distant Signal.
Home Signal.
Disc Signal.
Crossing Gate.
Turnstile.
Indicate Kind
Platform.
Cattle-Guard.
Trestle.
Truss.
Girder.
Arch.
Cast-iron Pipe.
3 Nozzles
Fire Hydrant.
Valve.
Riser.
Meter.
Manhole.

Catch Basin.

Sump.

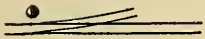
Arc Lamp.

Incandescent Lamp.

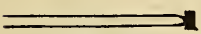
Gas Lamp.

Oil Lamp.

Automatic Bell.


Switchstand.

Interlocked Switch.


Bumping Post.

Train-Order Signal.

Derail.

Wagon Scales.

Section Post.

Signal Bridge.

Mail Crane.

Frame Buildings.

Brick Buildings.

Stone Buildings.

CONVENTIONAL SIGNS—GROUP 3.

Form M. W. 1022.

Steel.

Cast Steel.

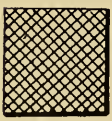
Cast-iron.

Wrought-iron.

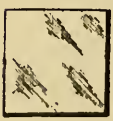
Brass.

Copper.

Lead.



Composition Metal.



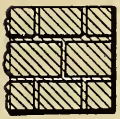
Glass.

Rubber.

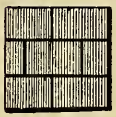
Timber.

Water.

Brick.



Ashlar Masonry.



Dressed Masonry.

Rubble Coursed.

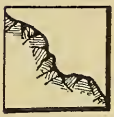
Rubble Uncoursed.

Rubble in Mortar.

Rubble—Dry.

Concrete.

Concrete and Steel.



Solid Rock.

Seamy Rock.

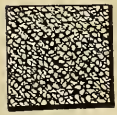
Earth.

Sand.

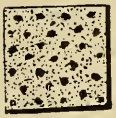
Gravel.

Marsh.

Mud.



Stone Ballast.



Cinder Ballast.

COMMITTEE NO XII.

UNIFORM RULES, ORGANIZATION, TITLES, CODE, ETC.

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*GENERAL RULES FOR THE GOVERNMENT OF EMPLOYÉS OF THE MAINTENANCE OF WAY DEPARTMENT.

RECOMMENDED GENERAL RULES.

GENERAL NOTICE.

To enter or remain in the service is an assurance of willingness to obey the rules.

Obedience to the rules is essential to the safety of passengers and employés, and to the protection of property.

The service demands the faithful, intelligent and courteous discharge of duty.

To obtain promotion, capacity must be shown for greater responsibility.

Employés in accepting employment assume its risks.

Employés in the Maintenance of Way Department must do all in their power to prevent accidents, even though in so doing they may occasionally have to perform someone else's duty.

GENERAL RULES.

(a) The Maintenance of Way Department on each division is in charge of .....(Title.)..... who will receive instructions from and report to .....(Title.).....

(b) The work of the Department will be subdivided under the following heads:

SUPERVISORS OF TRACK.

SUPERVISORS OF STRUCTURES.

SUPERVISORS OF SIGNALS.

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* Adopted, Vol. 7, 1906, pp. 20, 21, 26; Vol. 8, 1907, pp. 24-39.

RULES GOVERNING SUPERVISORS OF TRACK.

(1) They shall report to and receive instructions from the (Title.) .....

.....

(2) They shall be responsible for the safe condition and proper maintenance of track, roadway, right-of-way, station grounds and driveways. They must inform themselves of the condition of structures, make temporary repairs of such defects as may endanger or delay the movement of trains; and promptly report defective condition to.....(Title.).....

(3) They must frequently pass over their districts, observe the condition of track, roadway, right-of-way, station grounds and driveways, and have necessary repairs made as promptly as the conditions require.

(4) They shall employ, in the discharge of their work, such men as are necessary for carrying out the duties for which they are responsible.

(5) They must know that all foremen are provided with all rules, circulars, forms, and special instructions pertaining to their duties, and that they fully understand and comply with the same.

(6) They must see that all foremen are familiar with the rules in regard to train signals and flagging, and that they fully understand and comply with the same.

(7) They must know that all foremen are supplied with tools and material necessary for the efficient performance of their duties, and must see that they are properly cared for and used.

(8) They shall conform to the prescribed standards and plans in the execution of the work under their charge.

(9) They shall have immediate supervision of all work train service for the maintenance of track in their districts, and employ such service only when authorized by the .....(Title.)....., doing work by other means as far as practicable and economical.

(10) They must go promptly to the spot with the force, tools and materials necessary to effect clearance and repairs in cases of obstruction or damage to track or roadbed.

(11) They shall investigate and report on form No.....all accidents occurring in their districts, which may be attributable to or result in damage to track, roadbed or structures.

(12) They shall see that no encroachment upon or occupancy of any portion of the company's right-of-way is permitted, except by authority of the.....(Title.).....

(13) They shall not permit experimental trials of appliances or devices not standard with the company, nor give out information of the results of any trial, except by proper authority.

(14) They shall keep general oversight of all work performed in their districts by contractors or others who do not come under their direct charge, and see that nothing is done by them that will interfere with the safety of track or movement of trains.

(15) They shall see that all openings for the passage of water and the approaches and outlets thereto are kept free from brush, drift-wood, and other obstructions.

(16) They shall see that the vicinity of all bridges and trestles is cleared of all combustible matter, such as chips, bark, dried grass, etc.; and that bridge seats, tops of piers and bottom chords are kept cleaned of cinders and dirt, and that necessary water barrels at timber bridges and trestles are filled with water.

RULES GOVERNING SUPERVISORS OF STRUCTURES.

(1) They shall report to and receive instructions from the..... (Title.) .....

(2) They shall be responsible for the safe condition and proper maintenance of the structures in their districts. They must inform themselves of the condition of structures, make temporary repairs of such defects as may endanger or delay the movement of trains, and promptly report defective condition to.....(Title.).....

(3) They shall employ, in the discharge of their work, such men as are necessary for carrying out the duties for which they are responsible.

(4) They must know that all foremen are provided with all rules, circulars, forms, and special instructions pertaining to their duties, and that they fully understand and comply with the same.

(5) They must see that all foremen are familiar with the rules in regard to train signals and flagging, and that they fully understand and comply with the same.

(6) They must know that all foremen are supplied with tools and material necessary for the efficient performance of their duties, and must see that they are properly cared for and used.

(7) They shall conform to the prescribed standards and plans in the execution of the work under their charge.

(8) They shall have immediate supervision of all work train service

for the maintenance of structures in their districts, and employ such service only when authorized by the ..... (Title.) ....., doing work by other means as far as practicable and economical.

(9) They shall go promptly to the spot with the force, tools and materials necessary to effect clearance and repairs, in cases of obstruction or damage to structures.

(10) They must make frequent inspections of all structures in their districts and have necessary repairs made as promptly as conditions require.

(11) They shall, in period of flood, observe and record the flow of water of the various streams passing under the track and report to the proper officer from time to time where the area seems insufficient.

COMMITTEE NO. XIII.

WATER SERVICE.

*WATER-SOFTENING METHODS AND PLANTS FOR VARIOUS CONDITIONS.

CONCLUSIONS AND RECOMMENDED PRINCIPLES OF PRACTICE.

(1) All water used in locomotive boilers contains scale-forming matter in solution or suspension, causing much trouble and expense in operating and maintaining locomotives.

(2) In locating water stations along a railroad, an investigation should be made of all the available water supplies, and care should be taken to avoid the use of poor water, or to curtail its use as much as possible.

(3) If hard water is used, the hardness should be removed before it is put into locomotive boilers.

(4) Hard water can be softened by treating it with chemicals. The chemicals generally used are lime and soda ash.

(5) The chemical method of softening water, commonly used to-day, has been known for many years.

(6) The mechanical methods of modern water-softeners are new and differ widely.

(7) Water, whose hardness is due to carbonates of lime and magnesia, can be softened by the use of lime alone, without adding any soluble salts to the softened water.

(8) Water, whose hardness is due to sulphates of lime and magnesia, can be softened by the use of soda ash, but in this case soluble sulphate of soda should be added to the softened water.

(9) A water-softening method best adapted to any condition can be determined only after a study of that condition.

* Adopted, Vol. 6, 1905, pp. 601, 622-625.

*COMPARISON OF THE COST OF INSTALLING AND OPERATING WATER-SOFTENING PLANTS, WITH THE BENEFITS DERIVED FROM THEIR USE.

CONCLUSIONS AND RECOMMENDED PRINCIPLES OF PRACTICE.

(1) The cost of installing a water-softening plant varies according to the capacity of the plant, its type, cost of material and labor in its locality, and other local conditions.

(2) The cost of operating a water-softening plant varies according to the efficiency of the water-softening apparatus and the cost of lime and soda ash, or other chemicals available for softening water, in its locality.

(3) The cost of chemicals required to soften water varies according to the quantity of hardening matter in the water, and also its composition.

(4) If the hardening matter consists of carbonates of lime and magnesia, the cost of chemicals for softening the water will be very little, because common lime is the only chemical required.

(5) If the hardening matter consists of sulphates of lime and magnesia, the cost will be higher, because it will be necessary to use soda ash, or some more expensive chemical.

(6) The benefits derived from water-softening plants are:

Fewer boiler failures due to leaking.

Longer life of flues and firebox sheets.

Reduced cost of labor for repairing and washing boilers.

Increased locomotive mileage between shoppings.

Increased ton mileage per pound of coal consumed.

Decreased number of locomotives in service.

Shorter time required for locomotives going over the road.

Better feeling among the men, due to fewer failures and shorter time on the road.

Less expense in cost of overtime and delayed time.

* Adopted, Vol. 6, 1905, pp. 607, 608, 611, 625, 626.

*GENERAL CONDITIONS UNDER WHICH THE INSTALLATION OF A WATER-SOFTENING PLANT WOULD PRODUCE SAVINGS.

CONCLUSIONS AND RECOMMENDED PRINCIPLES OF PRACTICE.

(1) If a railroad runs through a region where hard water is the cause of trouble and expense, it would undoubtedly benefit that railroad to install water-softening plants. The actual benefits obtained from water-softening plants, as shown in reports obtained from five railroad companies, are evidences of this.

(2) If a railroad has increased the size of its locomotives and found that it has more boiler troubles due to hard water than it had with the smaller locomotives, it would be a benefit to install water-softening plants.

(3) It may be a benefit to soften any water used in locomotive boilers that contains 15 or more grains per gallon of hardening matter, or even less than 15 grains, if the hardening matter consists largely of sulphate of lime.

(4) It would not be of much benefit to soften a water that contains 50 grains per gallon of alkali salts before treatment, and also a considerable quantity of sulphate of lime, if soda ash is used to reduce the sulphate of lime, for although the water can be softened so that it will not make scale, yet it will cause trouble from foaming.

†EFFICIENCY OF WATER SOFTENERS.

CONCLUSIONS AND RECOMMENDED PRINCIPLES OF PRACTICE.

The greatest efficiency in the operation of a water-softening plant is produced by observing the following conditions:

(1) The solutions containing the reagent should be properly prepared.

(2) The reagents should be as near chemically pure as practicable.

(3) The mechanical device for introducing reagents must be such as to insure as near as possible a quantity of reagent in direct proportion to the flow of the untreated water.

(4) Where the lime and soda ash treatment is used, the volume of space for reaction and precipitation should be at least from three

* Adopted, Vol. 6, 1905, pp. 610, 611, 626-628.
† Adopted, Vol. 8, 1907, pp. 604-607, 615, 617, 620.

to four times the hourly capacity of the softener, depending on temperature and analysis of the water.

The equations for determining this space for both types of softeners, and Table No. 1, given below, conform to good practice.

In a continuous softener, the volume of the chambers through which the water passes, between the top of the portion reserved for sludge and the outlet through which the water finally flows to the storage tank, should be at least three times the hourly capacity of the plant, and where the temperature of the water is low, it should be four times the hourly capacity.

The determination of the number and volume of settling tanks for intermittent softeners depends on the number of pumps, or batteries of pumps, necessary to handle the water; time required to fill or empty each settling tank, above the sludge line, and time necessary for reaction and precipitation.

Where gravity flow, both to and from the softener, cannot be obtained, pumps will be needed with intermittent plants as follows:

One pump only is necessary:

(a) Where water is pumped to settling tanks and is transferred by gravity to storage tanks.

(b) Where water flows by gravity to settling tanks, and is transferred to storage tank by pumping.

(c) Where water is pumped to both the settling and storage tanks and the source of supply is ample to furnish double the capacity of the softening plant.

Two pumps are necessary:

(d) Where deep well pumps furnish supply and water must be pumped from settling tanks to storage tanks.

(e) Where water is handled by pumping to both settling and storage tanks, but the source of supply is not ample to furnish at least double the capacity of the plant.

In all of the cases where pumps are needed, excepting case "c," the capacity of each pump, or battery of pumps, used for each operation should be equal to at least the treating capacity of the softener. If the pumps used to transfer the treated water are of a larger capacity, so that water can be transferred to storage tanks in less time than is required to fill the settling tanks, less settling tank capacity will be required.

In case "c," as the pump must handle the water twice in its

transfer from the source of supply, through the softener and into the storage tank, its capacity should be at least equal to double the capacity of the softener, and the supply should be sufficient for the pump.

At least three feet of the bottom of each settling tank should be reserved for the accumulation of the precipitates; therefore, in estimating the settling space needed and the capacity of settling tanks, the settling space should be considered as lying entirely above this reserved portion.

With these points in mind, the proper capacities for settling tanks, measured above the space reserved for sludge, can be determined as follows:

a = capacity of softener in gallons per hour.
b = hours required for reaction and precipitation.
c = number of settling tanks (never less than 2).
x = number of hours required to fill the portion of settling tank above the "sludge" portion.
y = number of hours required to transfer treated water from one settling tank to the storage tank. (y should never be greater than x.)

In case "c," where one pump alternates between filling and emptying settling tanks, the time for filling and emptying the total number of tanks less one must equal the time for reaction and precipitation in that one, and x would equal y. As the capacity of the pump must be double the capacity of treating plant, the settling capacity in each tank would be $2ax$.

The equations expressing the above are:

$$2x\,(c-1) = b$$

$$x = \frac{b}{2c-2}$$

$$\text{Settling capacity each tank} = 2ax = \frac{2ab}{2c-2} = \frac{ab}{c-1}.$$

For plants where the quantity of water supplied to the softener and the capacity of the plant are equal, the settling capacity of each tank is equal to ax. The total number of hours required to fill all the settling tanks should equal the number of hours required to fill, precipitate and empty one tank, as expressed by following equation:

$$cx = x + b + y$$

$$x(c-1) = b + y$$

$$x = \frac{b+y}{c-1}$$

If $y = x$, then $x = \frac{b}{c-2}$; and $ax = \frac{ab}{c-2}$.

If $y = \frac{1}{2}x$, then $x = \frac{b}{c-1.5}$; and $ax = \frac{ab}{c-1.5}$.

Table No. 1 is developed from these equations and gives the proper settling capacity per 1,000 gallons per hour capacity of treating plant under various conditions and varying number of settling tanks. From this table it can be seen that with the same time allowed for reaction and precipitation, the least number and the smallest capacity of settling

TABLE No. 1.

PROPER SETTLING CAPACITY OF TANKS ABOVE THE PORTION RESERVED FOR SLUDGE, UNDER VARIOUS CONDITIONS OF OPERATION OF INTERMITTENT WATER SOFTENERS.

Number of Tanks. "c"	Time required, Each Tank.			Settling Capacity of Tanks per 1,000 Gallons, Capacity of Softener.	
	Filling. "x"	Reaction. "b"	Emptying. "y"	Each Tank.	Total.
When flow of water to softener is double the capacity of softener,					
2	2 Hours	4 Hours	2 Hours	4,000 Gals.	8,000 Gals.
3	1 "	4 "	1 "	2,000 "	6,000 "
4	2/3 "	4 "	2/3 "	1 333 "	5,333 "
2	1½ "	3 "	1½ "	3,000 "	6,000 "
3	¾ "	3 "	¾ "	1,500 "	4,500 "
4	½ "	3 "	½ "	1,000 "	4,000 "
When flow of water to softener equals the capacity of softener.					
3	4 Hours	4 Hours	4 Hours	4,000 Gals.	12,000 Gals.
4	2 "	4 "	2 "	2,000 "	8,000 "
5	1⅓ "	4 "	1⅓ "	1,333 "	6,667 "
6	1 "	4 "	1 "	1,000 "	6,000 "
2	8 "	4 "	4 "	8,000 "	16,000 "
3	2⅔ "	4 "	1⅓ "	2,667 "	8,000 "
4	1⅔ "	4 "	⅔ "	1,600 "	6,400 "
5	1⅐ "	4 "	⅘ "	1,143 "	5,714 "
3	3 "	3 "	3 "	3,000 "	9,000 "
4	1½ "	3 "	1½ "	1,500 "	6,000 "
5	1 "	3 "	1 "	1,000 "	5,000 "
2	6 "	3 "	3 "	6,000 "	12,000 "
3	2 "	3 "	1 "	2,000 "	6,000 "
4	1½ "	3 "	¾ "	1,200 "	4,800 "
5	6/7 "	3 "	6/7 "	857 "	4,286 "

tanks is required where the flow of the untreated water to the softener is double the hourly capacity of the softener, and the one pump works alternately filling and emptying these tanks. Where pumping is a necessity and sufficient supply can be obtained, this one pump plan will be the cheapest and most economical in maintenance and operation of the intermittent plants.

*RELATIVE ECONOMY OF DIFFERENT TYPES OF SOFTENERS.

CONCLUSIONS AND RECOMMENDED PRINCIPLES OF PRACTICE.

The relative economy of the different types of water softeners can be determined by comparing the total annual cost of each, excluding the cost of chemicals. This annual cost should be composed of:

(a) Interest on the sum of the cost of installation and value of ground space occupied;
(b) Depreciation;
(c) Current running repairs;
(d) Additional labor and fuel required above the ordinary cost of operating the water station.

†REAGENTS USED IN WATER-SOFTENING.

CONCLUSIONS AND RECOMMENDED PRACTICE.

The quantity of reagents required per unit of scaling or corroding substance held in solution, given in Table No. 2, is recommended as representing good practice.

Where the commercial product is not chemically pure, the proportion of reagents should be increased to correspond with an equivalent quantity of pure reagent.

Knowing the analysis of a water, the pounds of incrusting or corrosive matter held in solution per 1,000 gallons can be obtained by dividing the grains per gallon of each substance by seven, or the parts per 100,000 by twelve.

By using Table No. 2, the quantity of reagents per 1,000 gallons can be readily calculated, and by applying local cost of the same, the cost for chemicals per 1,000 gallons will be obtained. In order to know the full amount of lime necessary, the amount of free carbonic acid contained in the water should be determined, as well as the solids

* Adopted, Vol. 8, 1907, pp. 615, 620.
† Adopted, Vol. 8, 1907, pp. 608-610, 615, 621.

contained in solution, since this free acid must be eliminated in order to obtain efficient treatment of water and reduce scaling matter to the minimum.

TABLE No. 2.

QUANTITY OF PURE REAGENTS REQUIRED TO REMOVE ONE POUND OF INCRUSTING OR CORROSIVE MATTER FROM THE WATER.

Incrusting or Corrosive Substance Held in Solution	Amount of Reagent (Pure.)	Foaming Matter Increased.
Sulphuric acid	0.57 lb. lime plus 1.08 lbs. soda ash	1.45 lbs.
Free carbonic acid	1 27 lbs. lime	None
Calcium carbonate	0.56 lb. lime	None
Calcium sulphate	0 78 lb. soda ash	1.04 lbs.
Calcium chloride	0.96 lb soda ash	1.05 lbs.
Calcium nitrate	0.65 lb. soda ash	1.04 lbs.
Magnesium carbonate	1.33 lbs. lime	None
Magnesium sulphate	0.47 lb. lime plus 0.88 lb. soda ash	1.18 lbs.
Magnesium chloride	0.59 lb. lime plus 1.11 lbs. soda ash	1.22 lbs.
Magnesium nitrate	0.38 lb. lime plus 0.72 lb. soda ash	1.15 lbs.
Calcium carbonate	1 71 lbs. barium hydrate	None
Magnesium carbonate	4 05 lbs. barium hydrate	None
Magnesium sulphate	1.42 lbs. barium hydrate	None
[1]Calcium sulphate	1.26 lbs. barium hydrate	None

[1] In precipitating the calcium sulphate, there would also be precipitated 0.74 lb. of calcium carbonate or 0.31 lb. of magnesium carbonate, the 1.26 lbs. of barium hydrate performing the work of 0.41 lb. of lime and 0.78 lb. of soda ash, or for reacting on either magnesium or calcium sulphate, 1 lb. of barium hydrate performs the work of 0.33 lbs. of lime plus 0.62 lb. of soda ash, and the lime treatment can be correspondingly reduced.

*FOAMING OR PRIMING.

CONCLUSIONS AND RECOMMENDED PRACTICE.

Water having foaming matter in solution requires changing as the concentration of foaming solids in locomotive boilers reaches the critical point, i. e., about 100 grains per gallon.

The grains per gallon of foaming matter in solution represent the minimum per cent. of water wasted in locomotive boilers by blowing off and changing waters.

Treatment by soda ash increases foaming matter in solution, with a corresponding per cent. increase in water wasted equivalent to at least the grains increase of foaming matter per gallon.

For each pound additional foaming matter per 1,000 gallons of water, the increased expense would be equal to the cost of pumping and treating at least 70 gallons of water, and the fuel for heating the same to the temperature of boiler water. In addition to this expense, there would be the damage incurred to boilers by introducing cold feed water to replace water blown out, with the consequent cooling of tubes and sheets.

* Adopted, Vol. 8, 1907, pp. 615, 616, 621.

*MINIMUM QUANTITY OF SCALING AND CORROSIVE MATTER WHICH WILL JUSTIFY TREATMENT.

CONCLUSIONS AND RECOMMENDED PRINCIPLES OF PRACTICE.

The minimum quantity of solids in solution that will justify treatment depends on local conditions and the composition of the solids. By applying the proper local values to the equation given below, this quantity can be determined.

The following equation is given to show the point where the benefits derived from treating the water will just balance the cost of treating:

X = Number cwt. (100 lbs.) solids removed from water per annum.

B = Money value of benefits received from removing 100 lbs. solids; this will include:

Saving in boiler washing and repairs;

Saving in fuel.

Increased service received from locomotives, represented by the interest on the cost of the additional number of locomotives that would be required to perform the service rendered by locomotives using the soft water, if based on the performance prior to treating the water.

C = Cost per 100 lbs. of solids removed to operate the plant, as follows:

Additional cost of labor;

Additional cost of fuel or power;

Cost of chemicals;

Cost of current repairs.

D = Cost of plant installed.

I = Interest per annum on D.

L = Estimated useful life of plant in years.

R = Estimated value of materials recovered from plant after L years.

S = Annual depreciation of plant, equivalent to a sum per year, which, if placed in a sinking fund at I rate of interest, would amount to $D - R$ in L years. (See table, page 16, Kent's pocket book.)

* Adopted, Vol. 8, 1907, pp. 612, 613, 616, 622.

The benefits would just balance the cost when $XB = XC + I + S$. (1)

$$X = \frac{I + S}{B - C} \quad (2)$$

The number of pounds solids removed daily to make benefits just equal the cost would be $\frac{I + S}{3.65\,(B - C)}$ (3)

If more than this amount of solids is removed the plant will be profitable to the company.

Values for "B" can only be fixed for each particular case, as some of the matter held in solution is much more injurious than the same weight of other matters.

COMMITTEE NO. XIV.

YARDS AND TERMINALS.

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*YARDS AND TERMINALS.

DEFINITIONS.

TERMINALS.

TERMINAL.—The facilities provided by a railway at a terminus or at intermediate points on its line for the purpose of handling its business.

FREIGHT TERMINAL.—The arrangement of terminal facilities for the handling of freight business.

PASSENGER TERMINAL.—The arrangement of terminal facilities for the handling of passenger business.

YARDS.

YARD.—A system of tracks arranged in series, within defined limits, for separating and making up trains, storing cars, and other purposes.

RECEIVING YARD.—A yard for receiving incoming trains.

SEPARATING YARD.—A yard adjoining a receiving yard, in which cars are separated according to district, commodity, or other required order.

CLASSIFICATION YARD.—A yard adjoining a separating yard, in which cars are classified or grouped in accordance with requirements, preliminary to forwarding in trains.

DEPARTURE OR FORWARDING YARD.—A yard in which cars are assembled in trains for forwarding.

STORAGE YARD.—A yard in which cars are held awaiting disposition.

CLUSTER OR GENERAL YARD.—An arrangement of yards in series for the separation, classification, assembling and storage of cars.

GRAVITY YARD.—A yard in which the separation or classification of cars is aided by gravity.

ASSISTING GRADE.—The inclination given to tracks of a yard to facilitate the movement of cars.

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* Adopted, Vol. 2, 1901, pp. 39, 40, 46-59; Vol. 4, 1903, p. 349; Vol. 5, 1904, pp. 221, 224-226; Vol. 6, 1905, pp. 568-570, 575, 592; Vol. 7, 1906, pp. 153-155.

Poling Yard.—A yard in which the movement of cars is produced by the use of a pole or stake operated by an engine on an adjoining parallel track. The movement may be facilitated by an assisting grade.

Summit or Hump Yard.—A yard in which the movement of cars is produced by pushing them over a summit, beyond which they run by gravity. The movement from the base of the summit may be facilitated by an assisting grade.

TRACKS.

Body Track.—Each of the parallel tracks of a yard or group of tracks upon which cars are switched or stored.

Ladder Track.—A track connecting in series the body tracks of a yard.

Lead Track.—An extended track connecting either end of a yard with the main line.

Drill Track.—A track connecting with the ladder track and used for movements in yard switching.

Open Track.—A body track reserved for movements through a yard.

Running Track.—A track reserved for movements through a cluster or general yard.

Crossover Track.—A track connecting two adjacent tracks.

Special Tracks.—In a typical yard there will be several tracks devoted to special purposes, varying with the local conditions. These will include caboose tracks, scale tracks, coaling tracks, ash-pit tracks, bad-order tracks, repair tracks, icing tracks, feed tracks, stock tracks, transfer tracks, sand tracks, depressed tracks, etc.

Switching District.—That portion of a railway at a large terminal into which cars are moved and from which they are distributed to the various sidetracks and spurs to freight houses and manufacturing establishments served from this district, by yard or switching engines.

Rail and Water Terminal.—A terminal where freight is interchanged between railway cars and vessels.

Y Track.—A triangular arrangement of tracks used in place of a turntable for turning engines, cars or trains.

Transfer Slip.—A protected landing place for car floats, with adjustable apron for connecting the tracks of the pier and car float.

Siding or Side-Track.—A long track away from a yard connected with the main or running track at one or both ends and used for the storage or irregular movements of cars or trains.

Passing Siding.—A special siding, usually connected with the main track at both ends, and used to enable trains to pass each other.

Relief Track.—An extended passing siding, long enough to allow an inferior train to continue running.

Stub Track.—A short track connected with another at one end only.

Spur Track.—A stub track, usually leading to and serving an industry, or warehouse, freight house, etc.

House Track.—A track alongside or entering a freight house and used for cars receiving or delivering freight.

PIERS.

Lighterage Pier.—An open or covered pier at which freight is loaded directly from cars to vessels (or vice versa).

Export Pier.—A covered pier in which freight is unloaded and stored, mainly for shipment on ocean or coasting steamers.

Station Pier.—A covered pier having no rail connections, and where freight is received and delivered by car floats.

Coal Pier.—An open pier where coal is transferred from cars to vessels or barges.

*YARDS AND TERMINALS.

RECOMMENDED PRACTICE.

The following recommendations should be considered as embodying the general principles to be followed in yard design, although local conditions as to site or operation may frequently necessitate a deviation therefrom.

Body Tracks.—These should be spaced 11 ft. 6 in. to 13 ft. centers; and where they are parallel to the main track or other important running track they should be spaced not less than 16 ft. c. to c. from said track.

Ladder Tracks.—These should be spaced not less than 15 ft. c. to c. from any parallel track; and a No. 7 frog is the minimum number recommended for yard use.

Lead Tracks.—For safety the connections of these tracks with the main line should be interlocked; and to facilitate train movements, telegraphic connections should be established in the tower.

Drill Tracks.—These should be so located as to cause minimum interference with other movements.

Open Tracks.—The track selected as the open track should be one

* Adopted, Vol. 2, 1901, pp. 43-45; Vol. 3, 1902, pp. 267, 268, 280-288; Vol. 4, 1903, pp. 370-380; Vol. 5, 1904, pp. 182-184, 221-224; Vol. 6, 1905, pp. 570-574, 583, 592-594.

that will enable movements to be made from one end of the yard to the other with the greatest possible convenience.

Running Tracks.—These tracks should be provided for movements in either direction to enable yard engines to pass freely from one portion of the cluster or general yard to the other; also for road and yard engines to go to and from the engine house and other points where facilities are located.

Crossover Tracks.—Crossovers should be located at the most convenient points, and where they will least interfere with regular movements.

Caboose Tracks.—These tracks should ordinarily be located between the receiving and departure yards and so arranged that the caboose can readily be pushed thereon from a receiving track and then dropped by gravity to the train departing in the direction from which the caboose has arrived.

Scale Track.—These tracks should be located between the receiving and separating yards.

Coaling, Ash-pit, Sand and Engine Tracks.—These tracks should be located on the route leading to and from the engine house and should provide sufficient storage for the reception of engines by the hostler. They should be so arranged (1) that water, coal and sand can be taken and ashes disposed of in convenient rotation; and (2) that switching engines may clean fires, take coal, water and sand, and pass around waiting engines.

Bad-Order Tracks.—Where cars are classified, one or more of these tracks, easy of access, should be provided for setting off bad-order cars, and from which they can readily be removed to the repair tracks.

Repair Tracks.—These tracks should have a maximum capacity of about 15 cars each, spaced alternately 16 ft. and 24 ft. c. to c., and be connected conveniently with the bad-order tracks.

Icing Tracks.—These should be located between the receiving and separating yards so that the cars to be iced may readily be moved from the receiving to the icing track, and thence to the separating yard.

Cluster (or General Yard).—The main tracks should be located on the outside of the cluster, or general yard, with the engine house situated in the center.

Freight Car Repair Yard.—(See repair tracks.)

Coach Cleaning Yard.—This yard should be located for ready and quick access to and from the station. The tracks should be long enough to accommodate trains without cutting; and should be stub-ended, pref-

erably, with a car cleaner's repair and supply building located at right angles at their ends.

Inbound Freight House.—This house should be of such width as will furnish a reasonable amount of floor space for holding freight (50 ft. is a good average width). Usually not more than two tracks are needed, and these should be provided with platforms to avoid the necessity of spotting cars at the doors of the house.

Outbound Freight House.—In order to decrease trucking at this house it should be narrow (25 ft. is a good average width). It is of advantage to have a number of cars at the house so that all freight can be loaded into the cars direct; it is not advisable to load through more than four cars. Platforms should be provided between tracks to avoid necessity of spotting cars. Where a great number of cars are required the trucking distance will usually be decreased, and trucking through cars will also be avoided by having stub tracks running up to a freight house located at right angles to them; these tracks to be separated by covered platforms leading to the freight house.

Roadways.—Where the freight house is on one side and a wall on the other the minimum width of roadway should be 30 ft.; but where a freight house is on one side and a team track or another freight house is on the other the minimum clear width of roadway should be 40 ft.

Transfer House.—A transfer house should be located at a point where there is a coming together of the traffic and a necessity exists for its consolidation, and where the loaded equipment made empty can be used.

Cluster (or General Yard) at Rail-and-Water Terminals.—This should be so arranged that as trains come in the cars can readily be switched into the necessary classification and then moved to the proper point without interfering with the other movements.

Piers.—At rail-and-water terminals the piers should be designed with a view to the most efficient, rapid and economical handling of the business, and with a view also to the future development of this business. Care must be taken to give due weight to the special conditions and features of location, traffic, etc., which exist in every case and which render it impossible to lay down any but the most general rules for such piers. In every individual case the length, width, number of tracks, width of platform, details of construction and width of waterway between adjacent piers must be adjusted to best meet conditions as to shape and area of site as well as its relation to its approaches from both land and water, the character and volume of the business, and the manner in which it is to be handled.

Covered Lighterage Pier.—When conditions will permit, present practice will generally suggest a length of approximately 600 ft., with two depressed tracks. If the business to be handled over the pier is expected to move quickly the width should be no greater than is necessary to provide temporary storage and shelter for the goods during ordinary detentions while waiting for cars or lighters, preferably about 100 ft. If the movement is expected to be slow and it is necessary to provide storage while waiting for cars or vessels, or for assorting, classifying, inspecting or sale of goods, the width should be increased, but generally not beyond a width of 125 to 160 ft. If the movement is not expected to have a special character, or a mixed business is to be provided for, a compromise width of 125 ft. is suggested. The space between the shed and the outer edge of the pier should be not less than two feet, and the clear width of waterway between piers should be, if possible, not less than four times the width of the largest vessel to be handled.

Open Lighterage Pier.—This should, if possible, have a length of about 600 ft., and the width, number of tracks and the appliances for handling traffic should be adjusted to the particular use to which the pier is to be applied. On long piers, crossovers may be necessary.

For ordinary coarse freight in bulk, such as iron ore, stone, timber and similar products, the width should be from 50 to 80 ft., and there should be four tracks, with crossovers, to facilitate the handling of cars and avoid delay in transferring to or from vessels. If the business is light, or consists principally of heavy or costly products, such as cut stone, machinery, or miscellaneous freight not requiring shelter, a narrow pier of about 35 ft. in width, with two tracks only, is suggested.

Export and Storage Pier.—This should be designed with special reference to the character of the commodities to be handled; whether quick movement is expected or the goods are to be held some time in storage for the accumulation of full cargoes, or for inspection or classification. There should be two tracks in a depressed pit on the pier level, which, on long piers, should be properly connected by crossovers at convenient intervals to facilitate the movement of cars. On very wide piers additional tracks on the pier level are desirable under certain conditions. Where the water front is limited or very valuable and the conditions, volume and character of business warrant, pier sheds of two or more stories, with platform or barrel elevators and bag or barrel chutes are used. Under certain conditions additional tracks in the second story may prove more advantageous than elevators. The length should be sufficient

to properly accommodate either one or two vessels on each side at the same time, or approximately 600 to 1,400 ft. The width must be determined by the space available and the business to be handled. If quick moving, a width of 125 to 150 ft. is recommended. If slow moving, and large accumulations must be received and stored, the width may be extended, if space permits, to 300 or even 400 ft., but excessive width is not recommended on account of the consequent increase in cost of handling. The space between shed and face of pier should not be less than three nor more than six feet, and the clear waterway between piers should be, if possible, not less than four times the width of the largest vessels to be handled.

Coal Pier.—This should be an open pier, and where coal is to be delivered to vessels through pockets and chutes in the ordinary way, the pier should be high enough to allow coal from drop-bottom cars to be loaded by gravity into vessels or barges. It should have three or more tracks, the outside tracks for loaded cars and the inside one on an incline to return the empty cars to the yard by gravity. The length depends upon the grade necessary to reach the desired elevation, the length of the vessels to be coaled and the number of cars it is desired to unload at one time. Adjacent piers should be sufficiently distant to accommodate the class of service, which will depend on the length of the pier and the size of the water craft to be accommodated. Where coal cars are dumped by machinery which elevates and tilts the cars a high pier is not necessary, and it may be of any convenient height.

Station Pier.—A city station pier served by car floats should be approximately 600 ft. long and 125 ft. wide, with a depressed driveway in the center 35 ft. wide. It should be a closed pier, with 3-ft. platform outside. Adjacent parallel piers should be, if possible, 200 ft. apart in the clear. Along the water street should be a bulkhead, approximately 50 ft. wide, with two-story building, the upper floor being for offices, fruit auction room, etc.

Grain Elevators.—These should be so located that cars can be run into them and loaded or unloaded, the tracks being so located that cars will feed to and from the proper part of the cluster or general yard without interference with other movements. The tracks should be arranged to feed cars in at one end and out at the other. Where this cannot be done, the tracks should be so arranged as to allow shifts of cars to be made without stopping all work.

*RATING THE CAR STANDING CAPACITY OF TRACKS.

RECOMMENDED PRACTICE.

Forty (40) linear ft. of track per car is recommended in rating the car standing capacity of freight yard tracks.

†FREIGHT-CAR REPAIR YARDS.

CONCLUSIONS AND RECOMMENDED PRACTICE.

(1) Freight-Car Repair Yards should be composed of short tracks of a capacity of about fifteen cars each, arranged in pairs; the tracks of each pair spaced 16 ft. apart centers, and the pairs spaced 40 ft. apart centers.

(2) A material supply track should be placed in the space between each pair of tracks.

(3) In calculating the capacity of repair tracks a space of 50 ft. should be allowed for each car in order to provide working room about each car.

(4) Part of the yard should be provided with air and water pipes with outlets 50 ft. apart for testing cars.

(5) Heavy freight car repair tracks should be under cover, and provided with overhead traveling cranes to facilitate heavy lifting.

‡TEAM DELIVERY YARDS.

RECOMMENDED PRACTICE.

(1) Team Delivery Yards should be located convenient to the freight house, so that the receipt and shipment of freight may be easily under control of the freight agent's force.

(2) The tracks should be stub tracks, arranged in parallel pairs; the tracks of each pair spaced 12 ft. centers, and the pairs 52 ft. centers, and for convenience of shifting the tracks should be of about 20 cars capacity each.

(3) The yard should be provided with a crane for handling heavy freight.

(4) Ingress and egress for teams should be provided at each end of each teamway, if possible.

(5) Wagon scales should be provided handy to the team entrance of the yard, and track scales should be provided and located for convenient switching.

* Adopted, Vol. 6, 1905, pp. 579, 594.
† Adopted, Vol. 7, 1906, pp. 155, 170.
‡ Adopted, Vol. 7, 1906, pp. 155, 156, 171.

*HUMP YARDS.

CONCLUSIONS AND RECOMMENDED PRINCIPLES OF PRACTICE.

(1) Hump yards should consist of receiving, classification and departure tracks, in consecutive order as enumerated.

(2) A hump yard is a desirable form of yard for receiving, classifying and making up trains, because cars can be handled through it faster and at less cost than through any other form of yard.

(3) Each receiving track should be of sufficient length to hold a maximum train.

(4) Receiving tracks should be sufficient in number to hold a number of trains arriving in quick succession. The number will depend on the amount and character of traffic handled, and upon the relative location of the yard with respect to other yards and connections.

(5) If it is possible, the grades of the receiving tracks should be such that one engine can push the maximum train over the hump.

(6) No definite recommendations can be made for the length and number of classification tracks, except to say that they need not be full train length, except when used as departure tracks. Local conditions will govern.

(7) Departure tracks should be full train length and of sufficient number to provide ample standing room for trains while being tested for air and while waiting for engines.

(8) The departure yard should be provided with an air hose and air brake testing plant.

(9) Grades after leaving the summit should be such as to carry the cars to their proper destination in the yard.

(10) Where the cars to be classified are largely empty or light cars, the following grades are recommended for average conditions: 75 ft. of 1.5 per cent. up grade approaching summit; 300 ft. of 2.5 per cent. grade from the summit down; thence down through the several switches in the yard, 1.0 per cent.; thence down through the remainder of the yard, 0.5 per cent.

(11) Where the cars to be classified are largely loaded or heavy cars, the following grades are recommended for average conditions: 75 ft. of 1.5 per cent. up grade, approaching the summit; 300 ft. of 2 per cent. grade from the summit down; thence down through the several switches in the yard, 0.7 per cent.; thence down through the remainder of the yard, 0.3 per cent.

* Adopted, Vol. 7, 1906, pp. 152, 153, 168-170, 173-179.

(12) Where the traffic and climatic conditions require it, the grades should be made steeper in winter, and restored again in the spring.

(13) When required, scales should be located at such a distance from the summit (75 ft. is recommended) that when the car to be weighed reaches the scales it will be properly spaced from the following cars and running slowly enough to render correct weighing easy.

(14) For average conditions it is recommended that a No. 9 frog be the sharpest used for classification yards, making the angle of the body track with the ladder that of a No. 7 frog.

COMMITTEE NO. XV.

IRON AND STEEL STRUCTURES.

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*CONTRACTING FOR STEEL RAILROAD BRIDGES.

RECOMMENDED PRINCIPLES OF PRACTICE.

FIRST.—It is preferable for railroads to furnish general detailed plans and specifications of structural work to bidders, complete enough to show the exact character of the work; but if such plans cannot be furnished, the alternative to be full specifications, accompanied by outline plans and all information concerning the work.

SECOND.—It is preferable to invite bids on a pound price basis; and, if desired, alternate bids may be asked for the work, f. o. b. cars, and for the work erected. A lump sum bid is inadmissible unless general detailed plans and specifications are furnished.

THIRD.—It is preferable to invite bids for as large groups of bridges as can be defined consistently with the first recommendation, but when required to anticipate future requirements, it is not necessary for the railroad to submit designs if the nature of the work is known to the bidder by reason of having previously done work for the railroad or if standard designs of similar structures are submitted to the bidders.

FOURTH.—Wherever a bridge is to be erected on a line where traffic is to be maintained, it is recommended that the work should be done by the railroad force; but on small railroads where suitably organized and equipped forces for such work may not be justified, the large bridges, and in some cases all bridges, may be erected by contract.

FIFTH.—It is preferable in all cases that the railroad company furnish and lay the floor timber.

* Adopted, Vol. 7, 1906, pp. 184, 263, 264.

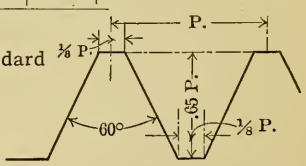
*STANDARD UPSETS.

RECOMMENDED STANDARD TABLE.

STANDARD UPSETS FOR ROUND AND SQUARE BARS.

ROUND BARS.						SQUARE BARS.					
Bar.	Upset.		Bar.	Upset.		Bar.	Upset.		Bar.	Upset.	
Diam. Inches.	Diam. Inches.	Length Inches.	Diam. Inches.	Diam. Inches.	Length Inches.	Side. Inches.	Diam. Inches.	Length Inches.	Side. Inches.	Diam. Inches.	Length Inches.
¾	1	4	2½	3	6	¾	1⅛	4	2⅛	3	6
⅞	1⅛	4	2⅝	3⅛	6½	⅞	1¼	4	2¼	3⅛	6½
1	1⅜	4	2¾	3¼	6½	1	1½	4	2⅜	3⅜	7
1⅛	1½	4	2⅞	3⅜	7	1⅛	1⅝	4½	2½	3½	7
1¼	1⅝	4½	3	3½	7	1¼	1¾	4½	2⅝	3⅝	8
1⅜	1¾	4½	3⅛	3⅝	8	1⅜	2	5	2¾	3⅞	8
1½	1⅞	4½	3¼	3¾	8	1½	2⅛	5	2⅞	4	8
1⅝	2	5	3⅜	3⅞	8	1⅝	2¼	5	3	4⅛	8½
1¾	2⅛	5	3½	4	8	1¾	2½	5½	3⅛	4⅜	9
1⅞	2¼	5	3⅝	4⅛	8½	1⅞	2⅝	5½	3¼	4½	9
2	2⅜	5½	3¾	4¼	8½	2	2⅞	6			
2⅛	2½	5½	3⅞	4⅜	9						
2¼	2¾	5½									
2⅜	2⅞	6									

Shape of thread, U. S. standard



Diameter of screw ends	1″	1⅛″	1¼″	1⅜″ and above.
No. of threads per inch	8	7	7	6

Minimum excess at root of thread over body of bar, 15 per cent.

* Adopted, Vol. 5, 1904, pp. 575, 580.

*GENERAL SPECIFICATIONS FOR STEEL RAILROAD BRIDGES.

RECOMMENDED STANDARD SPECIFICATIONS.

GENERAL SPECIFICATIONS FOR STEEL RAILROAD BRIDGES.

PART FIRST—DESIGN.

I. GENERAL FEATURES.

Kind of Material.

1. The material in the superstructure shall be structural steel, except rivets, and as may be otherwise specified.

Clearance.

2. On a straight line, the clear height of through bridges shall not be less than 21 ft. above top of rails for a width of 6 ft. over a single track, and the clear width shall be not less than 7 ft. from the center line of the track between the heights of 4 and 17 ft. above the rails. The width shall be increased to provide the same minimum clearance on curves, for a car 80 ft. long, 14 ft. high, and 60 ft. center to center of trucks, allowance being made for curvature and superelevation of rails.

Spacing Trusses.

3. The width center to center of girders and trusses shall in no case be less than one-twentieth of the effective span, nor less than is necessary to prevent overturning under the assumed lateral loading.

Skew Bridges.

4. Ends of deck plate girders and track stringers of skew bridges at abutments shall be square to the track, unless a ballasted floor is used.

Timber Floors.

5. Wooden tie floors shall be secured to the stringers and shall be proportioned to carry the maximum wheel load, with 100 per cent. impact, distributed over three ties, with fiber strain not to exceed 2,000 lbs. per sq. in. Ties shall not be less than 10 ft. in length. They shall be spaced with not more than 6-in. openings; and shall be secured against bunching.

II. LOADS.

Dead Load.

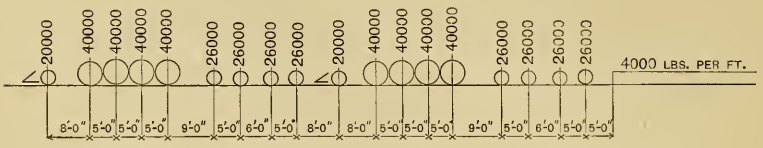
6. The dead load shall consist of the estimated weight of the entire suspended structure. Timber shall be assumed to weigh 4½ lbs. per ft. B. M.; ballast 100 lbs. per cu. ft., and rails and fastenings, 150 lbs. per linear ft. of track.

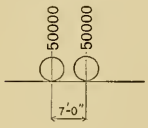
Moving Load.

†7. The live load, for each track, shall consist of two typical engines followed by a uniform load, according to Cooper's series, or a

* Adopted, Vol. 4, 1903, pp. 130-137, 141, 142, 253-279; Vol. 5, 1904, pp. 581-583; Vol. 6, 1905, pp. 228-237, 239, 448-455, 481; Vol. 7, 196, pp. 185-207, 236-263.
† See Addendum, clause (a).

system of loading giving practically equivalent strains. The minimum loading to be Cooper's E-40, as shown in the following diagrams:



and  the diagram that gives the larger strains to be used.

Heavier Loading.

*8. Heavier loadings shall be proportional to the above diagrams on the same spacing.

Impact.

9. The dynamic increment of the live load shall be added to the maximum computed live load strains and shall be determined by the formula $I = S \frac{300}{L + 300}$,

where I = impact or dynamic increment to be added to live-load strains.

S = computed maximum live-load strain.

L = loaded length of track in feet producing the maximum strain in the member. For bridges carrying more than one track, the aggregate length of all tracks producing the strain shall be used.

Impact shall not be added to strains produced by longitudinal, centrifugal and lateral or wind forces.

Lateral Load.

10. All spans shall be designed for a lateral force on the loaded chord of 200 lbs. per linear foot plus 10 per cent. of the specified train load on one track, and 200 lbs. per linear foot on the unloaded chord; these forces being considered as moving.

Wind Load.

11. Viaduct towers shall be designed for a force of 50 lbs. per sq. ft. on one and one-half times the vertical projection of the structure unloaded; or 30 lbs. per sq. ft. on the same surface plus 400 lbs. per linear ft. of structure applied 7 ft. above the rail for assumed wind load on train when the structure is either fully loaded or unloaded on either track with empty cars assumed to weigh 1,200 lbs. per linear ft., whichever gives the larger strain.

* See Addendum, clause (a).

12. Viaduct towers and similar structures shall be designed for a longitudinal force applied to the rail of 20 per cent. of the live load. Longitudinal Force.

*13. Structures located on curves shall be designed for the centrifugal force of the live load acting at a height of 6 ft. above the rail, proper account being taken of the superelevation; the speed and superelevation to be determined by the engineer for each case. Centrifugal Force.

III. UNIT STRAINS AND PROPORTION OF PARTS.

14. All parts of structures shall be so proportioned that the sum of the maximum strains shall not exceed the following amounts in pounds per sq. in., except as modified in paragraphs 20 to 23: Unit Strains.

15. Axial tension on net section.....16,000 Tension.

16. Axial compression on gross section.....$16{,}000 - 70\frac{l}{r}$ Compression.

where "l" is the length of member in inches and "r" is the least radius of gyration in inches.

Bending.

17. Bending: on extreme fibers of rolled shapes, built sections and girders; net section.....16,000
on extreme fibers of pins.....24,000

Shearing.

18. Shearing: shop driven rivets and pins.....12,000
field driven rivets and turned bolts.....10,000
plate girder webs; gross section.....10,000

Bearing.

†19. Bearing: shop driven rivets and pins.....24,000
field driven rivets and turned bolts.....20,000
granite masonry and Portland cement concrete..... 600
sandstone and limestone..... 400
expansion rollers; per linear inch..... $600\,d$
where "d" is the diameter of the roller in inches.

Alternate Strains.

20. Members subject to alternate strains of tension and compression shall be proportioned for the strains giving the largest section. If the alternate strains occur in succession during the passage of one train, as in stiff counters, each strain shall be increased by 50 per cent. of the smaller. The connections shall in all cases be proportioned for the sum of the strains.

Counter-Strains.

21. Wherever the live and dead load strains are of opposite character, only 70 per cent. of the dead load strain shall be considered as effective in counteracting the live load strain.

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* See Addendum, clause (b).
† See Addendum, clause (c).

Axial and Bending Strains Combined.

22. Members subject to both axial and bending strains shall be proportioned so that the combined fiber strains will not exceed the allowed axial strain.

Lateral and Other Strains Combined.

23. For strains produced by longitudinal and lateral or wind forces combined with those from live and dead load and centrifugal forces, the unit strain may be increased 25 per cent. over those given above; but the section shall not be less than required if the longitudinal and lateral or wind forces be neglected.

Net Section at Rivets.

24. In proportioning tension members the diameter of the rivet holes shall be taken ⅛-in. larger than the nominal diameter of the rivet.

Rivets.

25. In proportioning rivets the nominal diameter of the rivet shall be used.

Net Section at Pins.

26. Pin-connected riveted tension members shall have a net section through the pin-hole at least 25 per cent. in excess of the net section of the body of the member, and the net section back of the pin-hole, parallel with the axis of the member, shall be not less than the net section of the body of the member.

Proportioning Plate Girders.

27. Plate girders shall be proportioned either by the moment of inertia of their net section; or by assuming that the flanges are concentrated at their centers of gravity; in which case one-eighth of the gross section of the web, if properly spliced, may be used as flange section.

Compression Flange.

28. The gross section of the compression flanges of plate girders shall not be less than the gross section of the tension flanges; nor shall the strain per sq. in. in the compression flange of any beam or girder exceed $16{,}000 - 200\frac{l}{b}$, where l = unsupported distance and b = width of flange.

Flange Rivets.

29. The flanges of plate girders shall be connected to the web with a sufficient number of rivets to transfer the total shear at any point in a distance equal to the effective depth of the girder at that point combined with any load that is applied directly on the flange. The wheel loads, where the ties rest on the flanges, shall be assumed to be distributed over three ties.

Depth Ratios.

30. Trusses shall preferably have a depth of not less than one-tenth of the span. Plate girders and rolled beams, used as girders, shall preferably have a depth of not less than one-twelfth of the span. If shallower trusses, girders or beams are used, the section shall be

increased so that the maximum deflection will not be greater than if the above limiting ratios had not been exceeded.

IV. DETAILS OF DESIGN.

GENERAL REQUIREMENTS.

Open Sections.

31. Structures shall be so designed that all parts will be accessible for inspection, cleaning and painting.

Water Pockets.

32. Pockets or depressions which would hold water shall have drain holes, or be filled with waterproof material.

Symmetrical Sections.

33. Main members shall be so designed that the neutral axis will be as nearly as practicable in the center of section, and the neutral axes of intersecting main members of trusses shall meet at a common point.

Counters.

34. Rigid counters are preferred; and where subject to reversal of strain shall preferably have riveted connections to the chords. Adjustable counters shall have open turnbuckles.

Strength of Connections.

35. The strength of connections shall be sufficient to develop the full strength of the member, even though the computed strain is less, the kind of strain to which the member is subjected being considered.

Minimum Thickness.

36. The minimum thickness of metal shall be $\frac{3}{8}$-in., except for fillers.

Pitch of Rivets.

37. The minimum distance between centers of rivet holes shall be three diameters of the rivet; but the distance shall preferably be not less than 3 in. for $\frac{7}{8}$-in. rivets and $2\frac{1}{2}$ in. for $\frac{3}{4}$-in. rivets. The maximum pitch in the line of strain for members composed of plates and shapes shall be 6 in. for $\frac{7}{8}$-in. rivets and 5 in. for $\frac{3}{4}$-in. rivets. For angles with two gage lines and rivets staggered the maximum shall be twice the above in each line. Where two or more plates are used in contact, rivets not more than 12 in. apart in either direction shall be used to hold the plates well together. In tension members, composed of two angles in contact, a pitch of 12 in. will be allowed for riveting the angles together.

Edge Distance.

38. The minimum distance from the center of any rivet hole to a sheared edge shall be $1\frac{1}{2}$ in. for $\frac{7}{8}$-in. rivets and $1\frac{1}{4}$ in. for $\frac{3}{4}$-in. rivets, and to a rolled edge $1\frac{1}{4}$ and $1\frac{1}{8}$ in., respectively. The maximum distance from any edge shall be eight times the thickness of the plate, but shall not exceed 6 in.

Maximum Diameter.

39. The diameter of the rivets in any angle carrying calculated strain shall not exceed one-quarter the width of the leg in which they are driven. In minor parts $\frac{7}{8}$-in. rivets may be used in 3-in. angles, and $\frac{3}{4}$-in. rivets in $2\frac{1}{2}$-in. angles.

Long Rivets.

40. Rivets carrying calculated strain and whose grip exceeds four diameters shall be increased in number at least one per cent. for each additional $\frac{1}{16}$-in. of grip.

Pitch at Ends.

41. The pitch of rivets at the ends of built compression members shall not exceed four diameters of the rivets, for a length equal to one and one-half times the maximum width of member.

Compression Members.

42. In compression members the metal shall be concentrated as much as possible in webs and flanges. The thickness of each web shall be not less than one-thirtieth of the distance between its connections to the flanges. Cover plates shall have a thickness not less than one-fortieth of the distance between rivet lines.

Minimum Angles.

43. Flanges of girders and built members without cover plates shall have a minimum thickness of one-twelfth of the width of the outstanding leg.

Tie-Plates.

44. The open sides of compression members shall be provided with lattice and shall have tie-plates as near each end as practicable. Tie-plates shall be provided at intermediate points where the lattice is interrupted. In main members the end tie-plates shall have a length not less than the distance between the lines of rivets connecting them to the flanges, and intermediate ones not less than one-half this distance. Their thickness shall not be less than one-fiftieth of the same distance.

Lattice.

45. The minimum width of lattice bars shall be $2\frac{1}{2}$ in. for $\frac{7}{8}$-in. rivets, $2\frac{1}{4}$ in. for $\frac{3}{4}$-in. rivets, and 2 in. if $\frac{5}{8}$-in. rivets are used. The thickness shall not be less than one-fortieth of the distance between end rivets for single lattice, and one-sixtieth for double lattice. Shapes of equivalent strength may be used.

Rivets in Flanges.

46. Five-eighths-inch rivets shall be used for latticing flanges less than $2\frac{1}{2}$ in. wide, and $\frac{3}{4}$-in. for flanges from $2\frac{1}{2}$ to $3\frac{1}{2}$ in. wide; $\frac{7}{8}$-in. rivets shall be used in flanges $3\frac{1}{2}$ in. and over, and lattice bars with two rivets shall be used for flanges over 5 in. wide.

Angle of Lattice.

47. The inclination of lattice bars with the axis of the member shall be not less than 45 degrees, and when the distance between rivet lines in the flanges is more than 15 in., if single rivet bar is used, the lattice shall be double and riveted at the intersection.

Spacing of Lattice.

48. Lattice bars shall be so spaced that the portion of the flange included between their connection shall be as strong as the member as a whole.

Faced Joints.

49. Abutting joints in compression members when faced for bearing shall be spliced on four sides sufficiently to hold the connecting members

accurately in place. All other joints in riveted work, whether in tension or compression, shall be fully spliced.

Pin Plates.

50. Pin-holes shall be reinforced by plates where necessary, and at least one plate shall be as wide as the flanges will allow and be on the same side as the angles. They shall contain sufficient rivets to distribute their portion of the pin pressure to the full cross-section of the member.

Forked Ends.

51. Forked ends on compression members will be permitted only where unavoidable; where used, a sufficient number of pin plates shall be provided to make the jaws of twice the sectional area of the member. At least one of these plates shall extend to the far edge of the farthest tie-plate, and the balance not less than 6 in. beyond the near edge of the same plate.

Pins.

52. Pins shall be long enough to insure a full bearing of all the parts connected upon the turned body of the pin. They shall be secured by chambered nuts or be provided with washers if solid nuts are used. The screw ends shall be long enough to admit of burring the threads.

Filling Rings.

53. Members packed on pins shall be held against lateral movement.

Bolts.

54. Where members are connected by bolts, the turned body of these bolts shall be long enough to extend through the metal. A washer at least ¼-in. thick shall be used under the nut. Bolts shall not be used in place of rivets except by special permission. Heads and nuts shall be hexagonal.

Indirect Splices.

55. Where splice plates are not in direct contact with the parts which they connect, rivets shall be used on each side of the joint in excess of the number theoretically required to the extent of one-third of the number for each intervening plate.

Fillers.

56. Rivets carrying strain and passing through fillers shall be increased 50 per cent. in number; and the excess rivets, when possible, shall be outside of the connected member.

Expansion.

57. Provision for expansion to the extent of ⅛-in. for each 10 ft. shall be made for all bridge structures. Efficient means shall be provided to prevent excessive motion at any one point.

Expansion Bearings.

58. Spans of 80 ft. and over resting on masonry shall have turned rollers or rockers at one end; and those of less length shall be arranged to slide on smooth surfaces.

Fixed Bearings.

59. Movable bearings shall be designed to permit motion in one direction only. Fixed bearings shall be firmly anchored to the masonry.

Rollers.

60. Expansion rollers shall be not less than 6 in. in diameter. They shall be coupled together with substantial side bars, which shall be so arranged that the rollers can be readily cleaned.

Bolsters.

61. Bolsters or shoes shall be so constructed that the load will be distributed over the entire bearing. *[Spans of 80 ft. or over shall have hinged bolsters at each end.]

Wall Plates.

62. Wall plates may be cast or built up; and shall be so designed as to distribute the load uniformly over the entire bearing. They shall be secured against displacement.

Anchorage.

63. Anchor bolts for viaduct towers and similar structures shall be long enough to engage a mass of masonry the weight of which is at least one and one-half times the uplift.

Inclined Bearings.

64. Bridges on an inclined grade without pin shoes shall have the sole plates beveled so that the masonry and expansion surfaces may be level.

FLOOR SYSTEMS.

Floor Beams.

65. Floor beams shall preferably be square to the trusses or girders. They shall be riveted directly to the girders or trusses or may be placed on top of deck bridges.

Stringers.

66. Stringers shall preferably be riveted to the webs of all intermediate floor beams by means of connection angles not less than $\frac{7}{16}$-in. thick. Shelf angles or other supports provided to support the stringer during erection shall not be considered as carrying any of the reaction.

End Spacers for Stringers.

67. Where end floor beams cannot be used, stringers resting on masonry shall have cross frames near their ends. These frames shall be riveted to girder or truss shoe where practicable.

BRACING.

Rigid Bracing.

68. Lateral, longitudinal and transverse bracing in all structures shall be composed of rigid members.

Portals.

69. Through truss spans shall have riveted portal braces rigidly connected to the end posts and top chords. They shall be as deep as the clearance will allow.

Transverse Bracing.

70. Intermediate transverse frames shall be used at each panel of through spans having vertical truss members where the clearance will permit.

End Bracing.

71. Deck spans shall have transverse bracing at each end proportioned to carry the lateral load to the support.

Minimum Bracing.

72. The minimum sized angle to be used in lateral bracing shall be $3\frac{1}{2}$ by 3 by $\frac{3}{8}$-in. Not less than three rivets through the end of the angles shall be used at the connection.

* See Addendum, clause (d).

Bracing to Clear Ties.

73. Lateral bracing shall be far enough below the flange to clear the ties.

Tower Struts.

74. The struts at the foot of viaduct towers shall be strong enough to slide the movable shoes when the track is unloaded.

PLATE GIRDERS.

Camber.

75. *[If desired, plate girder spans over 50 ft. in length shall be built with camber at a rate of $\frac{1}{16}$-in. per 10 ft. of length.]

Top Flange Cover.

76. Where flange plates are used, one cover plate of top flange shall extend the whole length of the girder.

Web Stiffeners.

77. There shall be web stiffeners, generally in pairs, over bearings, at points of concentrated loading and at points required by the formula:

$$d = \frac{t}{40}(12{,}000 - s),$$

where d = clear distance, between stiffeners or flange angles.

t = thickness of web.

s = shear per sq. in.

The stiffeners at ends and at points of concentrated loads shall be proportioned by the formula of paragraph 16, the effective length being assumed as one-half the depth of girders. End stiffeners and those under concentrated loads shall be on fillers and have their outstanding legs as wide as the flange angles will allow and shall fit tightly against them. Intermediate stiffeners may be offset or on fillers, and their outstanding legs shall be not less than one-thirtieth of the depth of girder plus 2 in.

Stays for Top Flanges.

78. Through plate girders shall have their top flanges stayed at each end of every floor beam, or in case of solid floors, at distances not exceeding 12 ft., by knee braces or gusset plates.

TRUSSES.

Camber.

79. Truss spans shall be given a camber by making the panel length of the top chords, or their horizontal projections, longer than the corresponding panels of the bottom chord in the proportion of $\frac{1}{8}$-in. in 10 ft.

Rigid Members.

80. †Hip verticals and similar members, and the two end panels of the bottom chords of single track pin-connected trusses up to 300 ft. spans shall be rigid.

* See Addendum, clause (e).
† See Addendum, clause (f).

Eye-Bars.

81. The eye-bars composing a member shall be so arranged that adjacent bars shall not have their surfaces in contact; they shall be as nearly parallel to the axis of the truss as possible, the maximum inclination of any bar being limited to one inch in 16 ft.

Pony Trusses.

82. Pony trusses shall be riveted structures, with double webbed chords, and shall have all web members latticed or otherwise effectively stiffened.

PART SECOND—MATERIALS AND WORKMANSHIP.

V. MATERIAL.

83. Steel shall be made by the open-hearth process.

Process of Manufacture.

84. The chemical and physical properties shall conform to the following limits:

Schedule of Requirements.

Elements Considered.	Structural Steel.	Rivet Steel.	Steel Castings.
Phosphorus, max.... Basic	0.04 per cent.	0.04 per cent.	0.05 per cent.
Phosphorus, max.... Acid	0.08 "	0.04 "	0.08 "
Sulphur, maximum	0.05 "	0.04 "	0.05 "
Ultimate tensile strength.	Desired	Desired	Not less than
Pounds per square inch	60,000	50,000	65,000
Elong., min. % in 8", Fig. 1	1,500,000*	1,500,000	
" " " 2", " 2	Ult. tensile str'gth 22	Ult. tensile str'gth	18
Character of Fracture	Silky	Silky	Silky or fine granular
Cold Bends without Fracture	180° flat†	180° flat‡	90° d = 3t

* See paragraph 93. † See paragraphs 94, 95 and 96. ‡ See paragraph 97.

The yield point, as indicated by the drop of beam, shall be recorded in the test reports.

Allowable Variations.

85. If the ultimate strength varies more than 4,000 lbs. from that desired, a retest shall be made on the same gage, which, to be acceptable, shall be within 5,000 lbs. of the desired ultimate.

Chemical Analyses.

86. Chemical determinations of the percentages of carbon, phosphorus, sulphur and manganese shall be made by the manufacturer from a test ingot taken at the time of the pouring of each melt of steel, and a correct copy of such analysis shall be furnished to the engineer or his inspector. Check analyses shall be made from finished material, if called for by the purchaser, in which case an excess of 25 per cent. above the required limits will be allowed.

Form of Specimens.

87. PLATES, SHAPES AND BARS: Specimens for tensile and bending tests for plates, shapes and bars shall be made by cutting coupons from the finished product, which shall have both faces rolled and both edges milled to the form shown by Fig. 1; or with both edges parallel; or they may be turned to a diameter of ¾-in. for a length of at least 9 in., with enlarged ends.

88. RIVETS: Rivet rods shall be tested as rolled.

Form of Specimens.

89. PINS AND ROLLERS: Specimens shall be cut from the finished rolled or forged bar, in such manner that the center of the specimen shall be one inch from the surface of the bar. The specimen for tensile test shall be turned to the form shown by Fig. 2. The specimen for bending test shall be one inch by ½-in. in section.

90. STEEL CASTINGS: The number of tests will depend on the character and importance of the castings. Specimens shall be cut cold from coupons molded and cast on some portion of one or more castings from each melt or from the sink heads, if the heads are of sufficient size. The coupon or sink head, so used, shall be annealed with the casting before it is cut off. Test specimens to be of the form prescribed for pins and rollers.

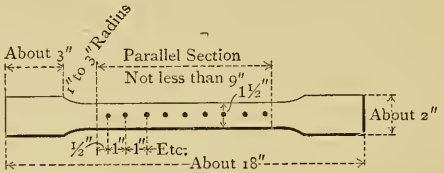

FIG. 1.

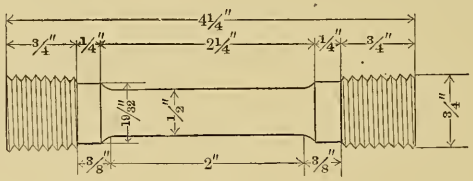

FIG. 2.

Annealed Specimens.

91. Material which is to be used without annealing or further treatment shall be tested in the condition in which it comes from the rolls. When material is to be annealed, or otherwise treated before use, the specimens for tensile tests representing such material shall be cut from properly annealed or similarly treated short lengths of the full section of the bar.

Number of Tests.

92. At least one tensile and one bending test shall be made from each melt of steel as rolled. In case steel differing ⅜-in. and more in thickness is rolled from one melt, a test shall be made from the thickest and thinnest material rolled.

Modifications in Elongation.

93. For material less than 5/16-in. and more than ¾-in. in thickness the following modifications will be allowed in the requirements for elongation:

(a) For each 1/16-in. in thickness below 5/16-in., a deduction of 2½ will be allowed from the specified percentage.

(b) For each 1/8-in. in thickness above 3/4-in., a deduction of 1 will be allowed from the specified percentage.

Bending Tests.

94. Bending tests may be made by pressure or by blows. Plates, shapes and bars less than one inch thick shall bend as called for in paragraph 84.

Thick Material.

95. Full-sized material for eye-bars and other steel one inch thick and over, tested as rolled, shall bend cold 180 degrees around a pin, the diameter of which is equal to twice the thickness of the bar, without fracture on the outside of bend.

Bending Angles.

96. Angles 3/4-in. and less in thickness shall open flat, and angles 1/2-in. and less in thickness shall bend shut, cold, under blows of a hammer, without sign of fracture. This test will be made only when required by the inspector.

Nicked Bends.

97. Rivet steel, when nicked and bent around a bar of the same diameter as the rivet rod, shall give a gradual break and a fine silky uniform fracture.

Finish.

98. Finished material shall be free from injurious seams, flaws, cracks, defective edges or other defects, and have a smooth, uniform and workmanlike finish. Plates 36 in. in width and under shall have rolled edges.

Stamping.

99. Every finished piece of steel shall have the melt number and the name of the manufacturer stamped or rolled upon it. Steel for pins and rollers shall be stamped on the end. Rivet and lattice steel and other small parts may be bundled with the above marks on an attached metal tag.

Defective Material.

100. Material which, subsequent to the above tests at the mills, and its acceptance there, develops weak spots, brittleness, cracks or other imperfections, or is found to have injurious defects, will be rejected at the shop and shall be replaced by the manufacturer at his own cost.

Allowable Variation in Weight.

101. A variation in cross-section or weight of each piece of steel of more than 2½ per cent. from that specified will be sufficient cause for rejection, except in case of sheared plates, which will be covered by the following permissible variations, which are to apply to single plates:

When Ordered to Weight.

102. Plates 12½ lbs. per sq. ft. or heavier:

(a) Up to 100 in. wide, 2½ per cent. above or below the prescribed weight.

(b) One hundred inches wide and over, 5 per cent. above or below.

When Ordered to Weight.

103. Plates under 12½ lbs. per sq. ft.:

(a) Up to 75 in. wide, 2½ per cent. above or below.

(b) Seventy-five inches and up to 100 in. wide, 5 per cent. above or 3 per cent. below.

(c) One hundred inches wide and over, 10 per cent. above or 3 per cent. below.

When Ordered to Gage.

104. Plates will be accepted if they measure not more than 0.01 in. below the ordered thickness.

105. An excess over the nominal weight, corresponding to the dimensions on the order, will be allowed for each plate, if not more than that shown in the following table, one cu. in. of rolled steel being assumed to weigh 0.2833 lb.:

Thickness Ordered	Nominal Weights	Width of Plate			
		Up to 75"	75" and up to 100"	100" and up to 115"	Over 115"
¼-inch	10.20 lbs.	10 per cent.	14 per cent.	18 per cent.	.....
5/16 "	12.75 "	8 "	12 "	16 "	.....
⅜ "	15.30 "	7 "	10 "	13 "	17 per cent.
7/16 "	17.85 "	6 "	8 "	10 "	13 "
½ "	20.40 "	5 "	7 "	9 "	12 "
9/16 "	22.95 "	4½ "	6½ "	8½ "	11 "
⅝ "	25.50 "	4 "	6 "	8 "	10 "
Over ⅝ "	.....	3½ "	5 "	6½ "	9 "

VI. SPECIAL METALS.

Cast-Iron.

106. Except where chilled iron is specified, castings shall be made of tough gray iron, with sulphur not over 0.10 per cent. They shall be true to pattern, out of wind and free from flaws and excessive shrinkage. If tests are demanded, they shall be made on the "Arbitration Bar" of the American Society for Testing Materials, which is a round bar 1¼ in. in diameter and 15 in. long. The transverse test shall be made on a supported length of 12 in. with load at middle. The minimum breaking load so applied shall be 2,900 lbs., with a deflection of at least $\frac{1}{10}$-in. before rupture.

Wrought-Iron Bars.

107. Wrought-iron shall be double-rolled, tough, fibrous and uniform in character. It shall be thoroughly welded in rolling and be free from surface defects. When tested in specimens of the form of Fig. 1, or in full-sized pieces of the same length, it shall show an ultimate strength of at least 50,000 lbs. per sq. in., an elongation of at least 18 per cent. in 8 in., with fracture wholly fibrous. Specimens shall bend cold, with the fiber, through 135 degrees, without sign of fracture, around a pin the diameter of which is not over twice the thickness of the piece tested.

When nicked and bent, the fracture shall show at least 90 per cent. fibrous.

VII. INSPECTION AND TESTING AT THE MILLS.

Copies of Mill Orders.

108. The purchaser shall be furnished complete copies of mill orders, and no material shall be rolled, nor work done, before the purchaser has been notified where the orders have been placed, so that he may arrange for the inspection.

Facilities for Inspection.

109. The manufacturer shall furnish all facilities for inspecting and testing the weight and quality of all material at the mill where it is manufactured. He shall furnish a suitable testing machine for testing the specimens, as well as prepare the pieces for the machine, free of cost.

Access to Mills.

110. When an inspector is furnished by the purchaser to inspect material at the mills, he shall have full access, at all times, to all parts of mills where material to be inspected by him is being manufactured.

VIII. WORKMANSHIP.

General.

111. All parts forming a structure shall be built in accordance with approved drawings. The workmanship and finish shall be equal to the best practice in modern bridge works.

Straightening Material.

112. Material shall be thoroughly straightened in the shop, by methods that will not injure it, before being laid off or worked in any way.

Finish.

113. Shearing shall be neatly and accurately done and all portions of the work exposed to view neatly finished.

Size of Rivets.

114. The size of rivets, called for on the plans, shall be understood to mean the actual size of the cold rivet before heating.

Rivet Holes.

115. When general reaming is not required, the diameter of the punch shall not be more than $\frac{1}{16}$-in. greater than the diameter of the rivet; nor the diameter of the die more than $\frac{1}{8}$-in. greater than the diameter of the punch. Material more than $\frac{3}{4}$-in. thick shall be sub-punched and reamed or drilled from the solid.

Punching.

116. All punching shall be accurately done. Drifting to enlarge unfair holes will not be allowed. If the holes must be enlarged to admit the rivet, they shall be reamed. Poor matching of holes will be cause for rejection.

Sub-punching and Reaming.

117. Where reaming is required, the punch used shall have a diameter not less than $\frac{3}{16}$-in. smaller than the nominal diameter of the rivet. Holes shall then be reamed to a diameter not more than $\frac{1}{16}$-in.

larger than the nominal diameter of the rivet. All reaming shall be done with twist drills. (See 132.)

Reaming after Assembling.

118. *[When general reaming is required it shall be done after the pieces forming one built member are assembled and firmly bolted together. If necessary to take the pieces apart for shipping and handling, the respective pieces reamed together shall be so marked that they may be reassembled in the same position in the final setting up. No interchange of reamed parts will be allowed.]

Edge Planing.

119. †[Sheared edges or ends shall, when required, be planed at least ⅛-in.]

Burrs.

120. The outside burrs on reamed holes shall be removed.

Assembling.

121. Riveted members shall have all parts well pinned up and firmly drawn together with bolts, before riveting is commenced. Contact surfaces to be painted. (See 149.)

Lattice Bars.

122. Lattice bars shall have neatly rounded ends, unless otherwise called for.

Web Stiffeners.

123. Stiffeners shall fit neatly between flanges of girders. Where tight fits are called for, the ends of the stiffeners shall be faced and shall be brought to a true contact bearing with the flange angles.

Splice Plate and Fillers.

124. Web splice plates and fillers under stiffeners shall be cut to fit within ⅛-in. of flange angles.

Web Plates.

125. Web plates of girders, which have no cover plates, shall be flush with the backs of angles or project above the same not more than ⅛-in., unless otherwise called for. When web plates are spliced, not more than ¼-in. clearance between ends of plates will be allowed.

Connection Angles.

126. Connection angles for floor beams and stringers shall be flush with each other and correct as to position and length of girder. In case milling *[of all such angles] is needed or is required after riveting, the removal of more than 1/16-in. from their thickness will be cause for rejection..

Rivets.

127. Rivets shall be driven by pressure tools wherever possible. Pneumatic hammers shall be used in preference to hand driving.

Riveting.

128. Rivets shall look neat and finished, with heads of approved shape, full and of equal size. They shall be central on shank and grip the assembled pieces firmly. Recupping and calking will not be allowed. Loose, burned or otherwise defective rivets shall be cut out and replaced. In cutting out rivets, great care shall be taken not to injure the adjacent metal. If necessary, they shall be drilled out.

* See Addendum, clause (g).
† See Addendum, clause (h).
‡ See Addendum, clause (i).

Turned Bolts.

129. Wherever bolts are used in place of rivets which transmit shear, the holes shall be reamed parallel and the bolts turned to a driving fit. A washer not less than ¼-in. thick shall be used under nut.

Members to Be Straight.

130. The several pieces forming one built member shall be straight and fit closely together, and finished members shall be free from twists, bends or open joints.

Finish of Joints.

131. Abutting joints shall be cut or dressed true and straight and fitted close together, especially where open to view. In compression joints, depending on contact bearing, the surfaces shall be truly faced, so as to have even bearings after they are riveted up complete and when perfectly aligned.

Field Connections.

132. Holes for floor beam and stringer connections shall be sub-punched and reamed according to paragraph 117, to a steel templet one inch thick. *[If required, all other field connections, except those for laterals and sway bracing, shall be assembled in the shop and the unfair holes reamed; and when so reamed, the pieces shall be match-marked before being taken apart.]

Eye-Bars.

133. Eye-bars shall be straight and true to size, and shall be free from twists, folds in the neck or head, or any other defect. Heads shall be made by upsetting, rolling or forging. Welding will not be allowed. The form of heads will be determined by the dies in use at the works where the eye-bars are made, if satisfactory to the engineer, but the manufacturer shall guarantee the bars to break in the body when tested to rupture. The thickness of head and neck shall not vary more than $\frac{1}{16}$-in. from that specified. (See 160.)

Boring Eye-Bars.

134. Before boring, each eye-bar shall be properly annealed and carefully straightened. Pin-holes shall be in the center line of bars and in the center of heads. Bars of the same length shall be bored so accurately that, when placed together, pins $\frac{1}{32}$-in. smaller in diameter than the pin-holes can be passed through the holes at both ends of the bars at the same time without forcing.

Pin Holes.

135. Pin-holes shall be bored true to gages, smooth and straight; at right angles to the axis of the member and parallel to each other, unless otherwise called for. The boring shall be done after the member is riveted up.

Variation in Pin Holes.

136. The distance center to center of pin-holes shall be correct within $\frac{1}{32}$-in., and the diameter of the holes not more than $\frac{1}{50}$-in. larger than that of the pin, for pins up to 5-in. diameter, and $\frac{1}{32}$-in. for larger pins.

* See Addendum, clause (j).

Pins and Rollers.

137. Pins and rollers shall be accurately turned to gages and shall be straight and smooth and entirely free from flaws.

Screw Threads.

138. Screw threads shall make tight fits in the nuts and shall be U. S. standard, except above the diameter of 1⅜ in., when they shall be made with six threads per inch.

Annealing.

139. Steel, except in minor details, which has been partially heated, shall be properly annealed.

Steel Castings.

140. All steel castings shall be annealed.

Welds.

141. Welds in steel will not be allowed.

Bed Plates.

142. Expansion bed plates shall be planed true and smooth. Cast wall plates shall be planed top and bottom. The cut of the planing tool shall correspond with the direction of expansion.

Pilot Nuts.

143. Pilot and driving nuts shall be furnished for each size of pin, in such numbers as may be ordered.

Field Rivets.

144. Field rivets shall be furnished to the amount of 15 per cent. plus ten rivets in excess of the nominal number required for each size.

Shipping Details.

145. Pins, nuts, bolts, rivets and other small details shall be boxed or crated.

Weight.

146. The weight of every piece and box shall be marked on it in plain figures.

Finished Weight.

147. Payment for pound price contracts shall be by scale weight. No allowance over 2 per cent. of the total weight of the structure as computed from the plans will be allowed for excess weight.

IX. SHOP PAINTING.

Cleaning.

*148. Steel work, before leaving the shop, shall be thoroughly cleaned and given one good coating of pure linseed oil, or such paint as may be called for, well worked into all joints and open spaces.

Contact Surfaces.

149. In riveted work, the surfaces coming in contact shall each be painted before being riveted together.

Inaccessible Surfaces.

150. Pieces and parts which are not accessible for painting after erection, including tops of stringers, eye-bar heads, ends of posts and chords, etc., shall have a good coat of paint before leaving the shop.

Condition of Surfaces.

151. Painting shall be done only when the surface of the metal is perfectly dry. It shall not be done in wet or freezing weather, unless protected under cover.

Machine-Finished Surfaces.

152. Machine-finished surfaces shall be coated with white lead and tallow before shipment or before being put out into the open air.

* See Addendum, clause (k).

X. INSPECTION AND TESTING AT THE SHOPS.

Facilities for Inspection.

153. The manufacturer shall furnish all facilities for inspecting and testing the weight and quality of workmanship at the shop where material is manufactured. He shall furnish a suitable testing machine for testing full-sized members, if required.

Starting Work in Shop.

154. The purchaser shall be notified well in advance of the start of the work in the shop, in order that he may have an inspector on hand to inspect material and workmanship.

Access to Shop.

155. When an inspector is furnished by the purchaser, he shall have full access, at all times, to all parts of the shop where material under his inspection is being manufactured.

Accepting Material or Work.

156. The inspector shall stamp each piece accepted with a private mark. Any piece not so marked may be rejected at any time, and at any stage of the work. If the inspector, through an oversight or otherwise, has accepted material or work which is defective or contrary to the specifications, this material, no matter in what stage of completion, may be rejected by the purchaser.

Shop Plans.

157. The purchaser shall be furnished complete shop plans.

Shipping Invoices.

158. Complete copies of shipping invoices shall be furnished to the purchaser with each shipment.

XI. FULL-SIZED TESTS.

Test to Prove Workmanship.

159. Full-sized tests on eye-bars and similar members, to prove the workmanship, shall be made at the manufacturer's expense, and shall be paid for by the purchaser at contract price, if the tests are satisfactory. If the tests are not satisfactory, the members represented by them will be rejected.

Eye-Bar Tests.

160. In eye-bar tests, the fracture shall be silky, the elongation in 10 ft., including the fracture, shall be not less than 15 per cent.; and the ultimate strength and true elastic limit shall be recorded. (See 133.)

ADDENDUM TO GENERAL SPECIFICATIONS FOR STEEL RAILROAD BRIDGES.

POINTS TO BE SPECIFICALLY DETERMINED BY BUYERS WHEN SOLICITING PROPOSALS FOR STEEL RAILROAD BRIDGES.

When general detailed drawings are not furnished for the use of bidders, specific answers should be given to points a, b, c, d, e, f, k and l, below.

Specific answers should also be given to points g, h, i, and j, if the class of work described in any of the paragraphs there referred to is desired. If these features are not specifically demanded, the unbracketed paragraphs will be construed to define the kind of work desired.

(a) Specify class of live load. (Pars. 7 and 8.)

(b) If bridge is on curve, specify speed and superelevation. (Par. 13.)

(c) Specify the kind of masonry on which the bridge will rest. (Par. 19.)

(d) Shall hinged bolsters be used on spans of 80 ft. and over? (Par. 61.)

(e) Shall plate girders over 50 ft. long be built with camber? (Par. 75.)

(f) Shall end panels of lower chords in double track pin trusses, or in single track pin trusses over 300 ft. span, be riveted members? (Par. 80.)

(g) Shall general reaming be done? (Par. 118.)

(h) Shall edge planing be done? If so, specify on what members. (Par. 119.)

(i) Shall all floor connection angles be milled after riveting? (Par. 126.)

(j) Shall field connections be assembled at the shop? (Par. 132.)

(k) Specify kind of oil or paint to be used. (Pars. 148-152.)

(l) Give schedule of floor bolts if these are to be furnished by the contractor.

CLASSIFICATION OF TRACK.

*CLASSIFICATION OF TRACK.

RECOMMENDED CLASSIFICATION.

Class "A" shall include all districts of a railway having more than one main track, or those districts of a railway having a single main track with a traffic that equals or exceeds the following:

Freight car mileage passing over district per year per mile, 150,000; or, Passenger car mileage per year per mile of district, 10,000; with maximum speed of passenger trains of 50 miles per hour.

Class "B" shall include all districts of a railway having a single main track with a traffic that is less than the minimum prescribed for Class "A," and that equals or exceeds the following:

Freight car mileage passing over district per year per mile, 50,000; or, Passenger car mileage per year per mile of district, 5,000; with maximum speed of passenger trains of 40 miles per hour.

Class "C" shall include all districts of a railway not meeting the traffic requirements of Classes "A" or "B."

* Vol. 7, 1906, pp. 331, 340; adopted by Letter Ballot, June, 1906; Vol. 8, 1907, p. 15.

APPENDIX

*GENERAL RULES FOR PUBLICATION OF "MANUAL OF RECOMMENDED PRACTICE."

(1) The title of the volume shall be *"Manual of Recommended Practice for Railway Engineering and Maintenance of Way,* containing the Definitions, Specifications and Principles of Practice adopted and recommended by the American Railway Engineering and Maintenance of Way Association," edited under the direction of the Committee on Publications and publication approved by the Board of Direction.

(2) The adoption by the Association and subsequent publication of any matter in the Manual shall be considered in the nature of *recommended practice* and shall not be binding on the members.

(3) The Manual shall include only resolutions, conclusions, recommendations, plans, etc., relating to definitions, specifications or principles of practice of such questions connected with railway engineering and maintenance of way work which have been made the subject of a special study by a standing or special committee and embodied in a committee report, published not less than thirty days prior to the annual convention, and submitted by the committee at the annual convention, and which, after due consideration and discussion, shall have been voted on and formally adopted by the Association.

(4) Any matter published in the Manual may be amended, revised, extended or withdrawn by vote at any subsequent annual convention, provided such changes are proposed in time for publication not less than thirty days prior to the annual convention, and in the following manner: (a) Upon recommendation of the committee in charge of the subject; (b) upon recommendation of the Board of Direction; (c) upon request of five members, subject to the action of the Board of Direction under Rule (6).

(5) All resolutions, conclusions, recommendations, specifications, standards, etc., in order to be included in the Manual, must be in concise and proper final shape for publication, as the Manual will consist only of a summary record of the definitions, principles of practice, specifications and standards recommended by the Association, with a brief reference to the published Proceedings of the Association for the context of the committee report and subsequent discussions and the final action by the Association.

(6) The Board of Direction shall have authority to exclude from the Manual any matter which, in its judgment, it shall consider as not desirable to publish, or as not being in proper shape, or as not having received proper study and consideration.

(7) The Manual will be revised annually and kept up-to-date by publishing a new edition or a supplemental pamphlet as promptly as possible after each annual convention.

* Adopted, March, 1905.

NOTICE OF SECRETARY RELATIVE TO SALE OF PUBLICATIONS.

The Association issues three publications—the monthly Bulletin, the annual volume of Proceedings and the Manual of Recommended Practice, which are furnished to all members, and will be sent postpaid to non-members on payment of prices quoted below:

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